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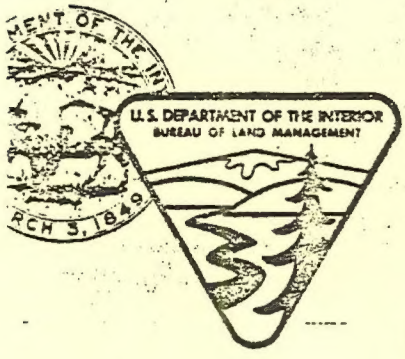

TECHNICAL NOTES

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February 1, 1968

CARBOHYDRATE RESERVES OF RANGE PLANTS

The knowledge of carbohydrate reserves in plants is very useful in planning seasons of grazing use for allotment management plans. This knowledge is helpful in propagating desirable species and can also be used to help control some less desirable plants.

The attached graphs may help you plan seasons of grazing use to take advantage of the carbohydrate reserve pattern of the plants listed. This information is not intended to replace data gathered locally but might be of some use in the meantime.

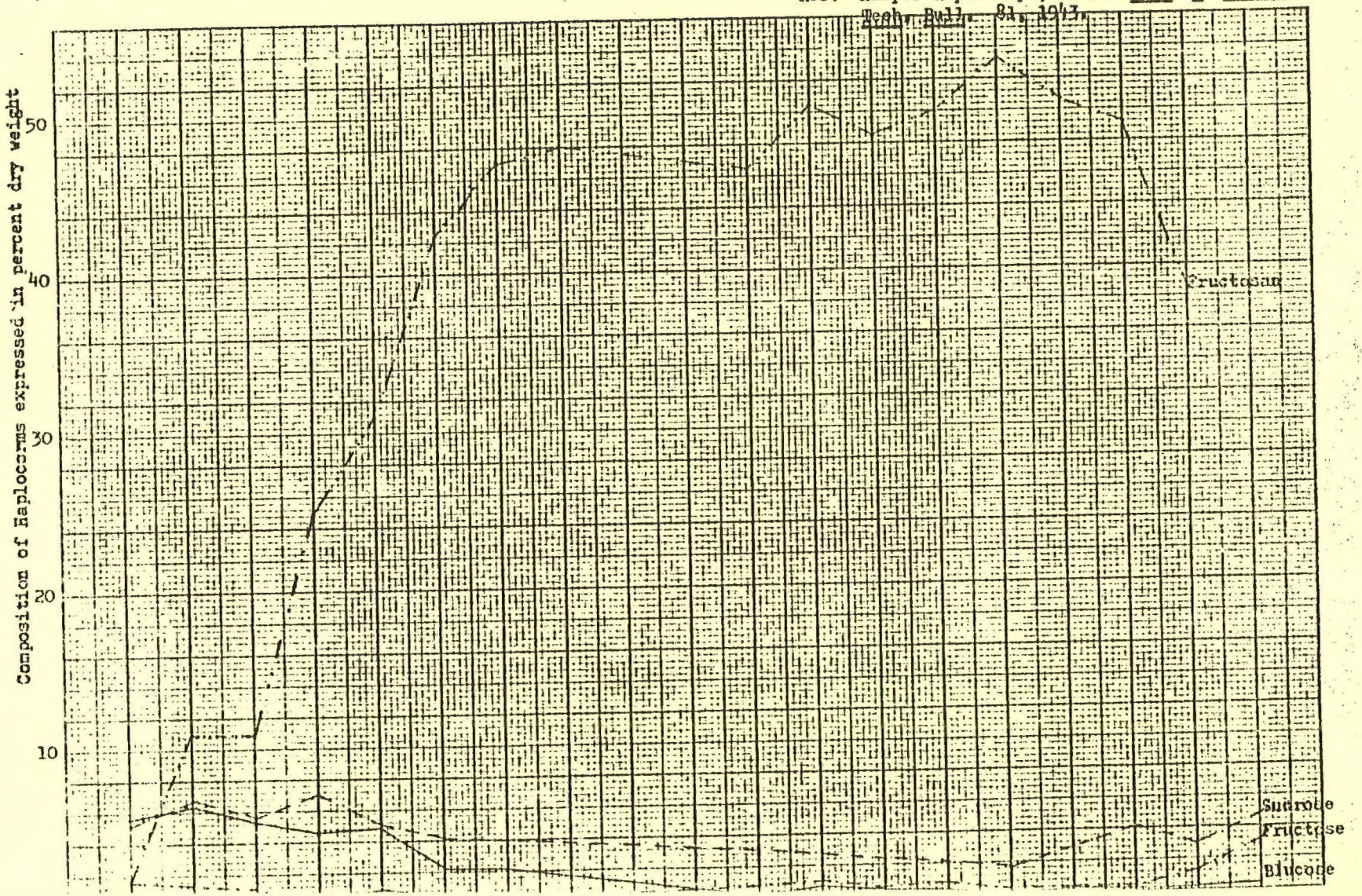
More information on the use of this material may be obtained from two publications by the Utah Agricultural Experiment Station - Logan, Utah:

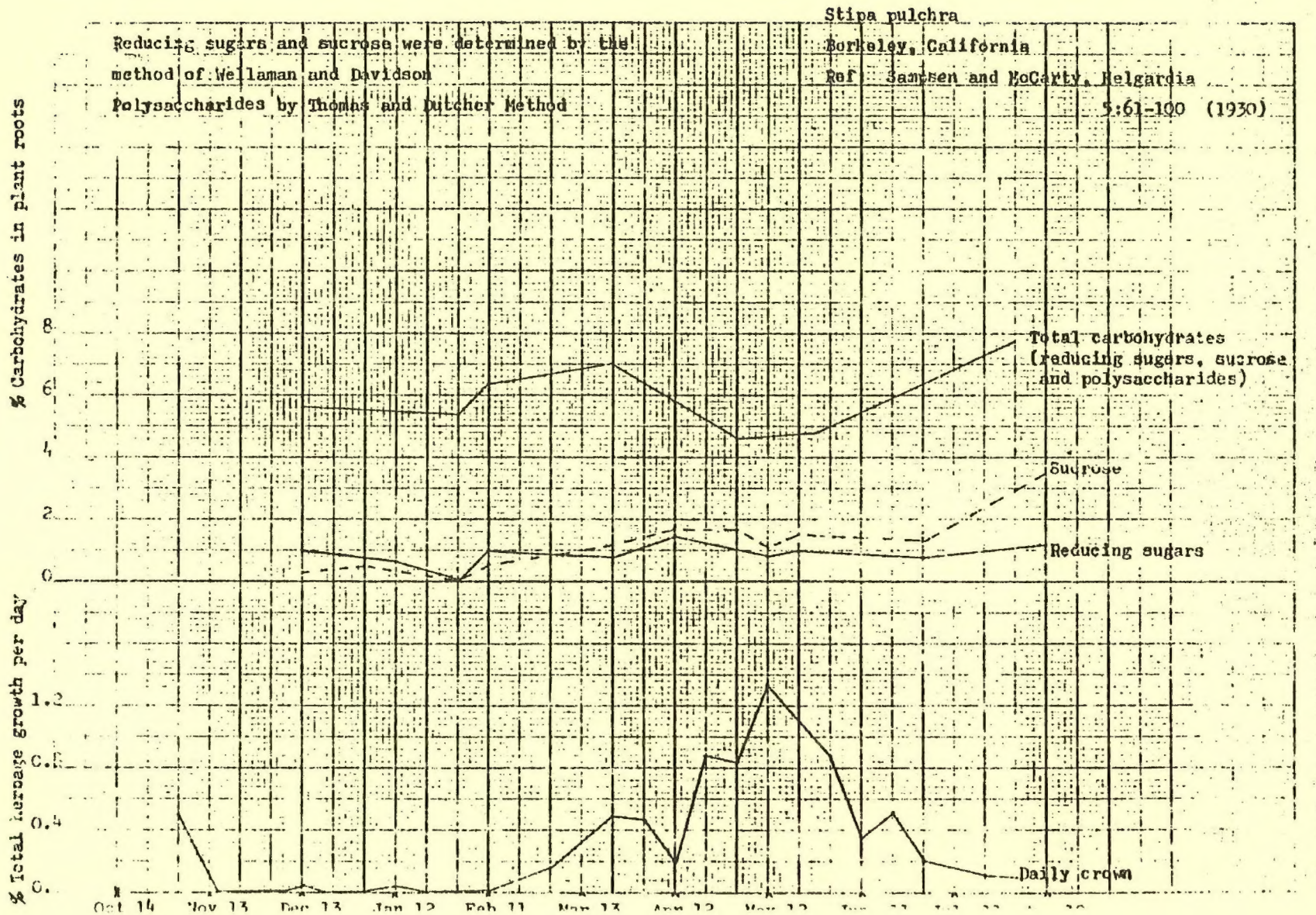
1. Carbohydrate Reserves in Plants, Utah Resources Series 31, June, 1966

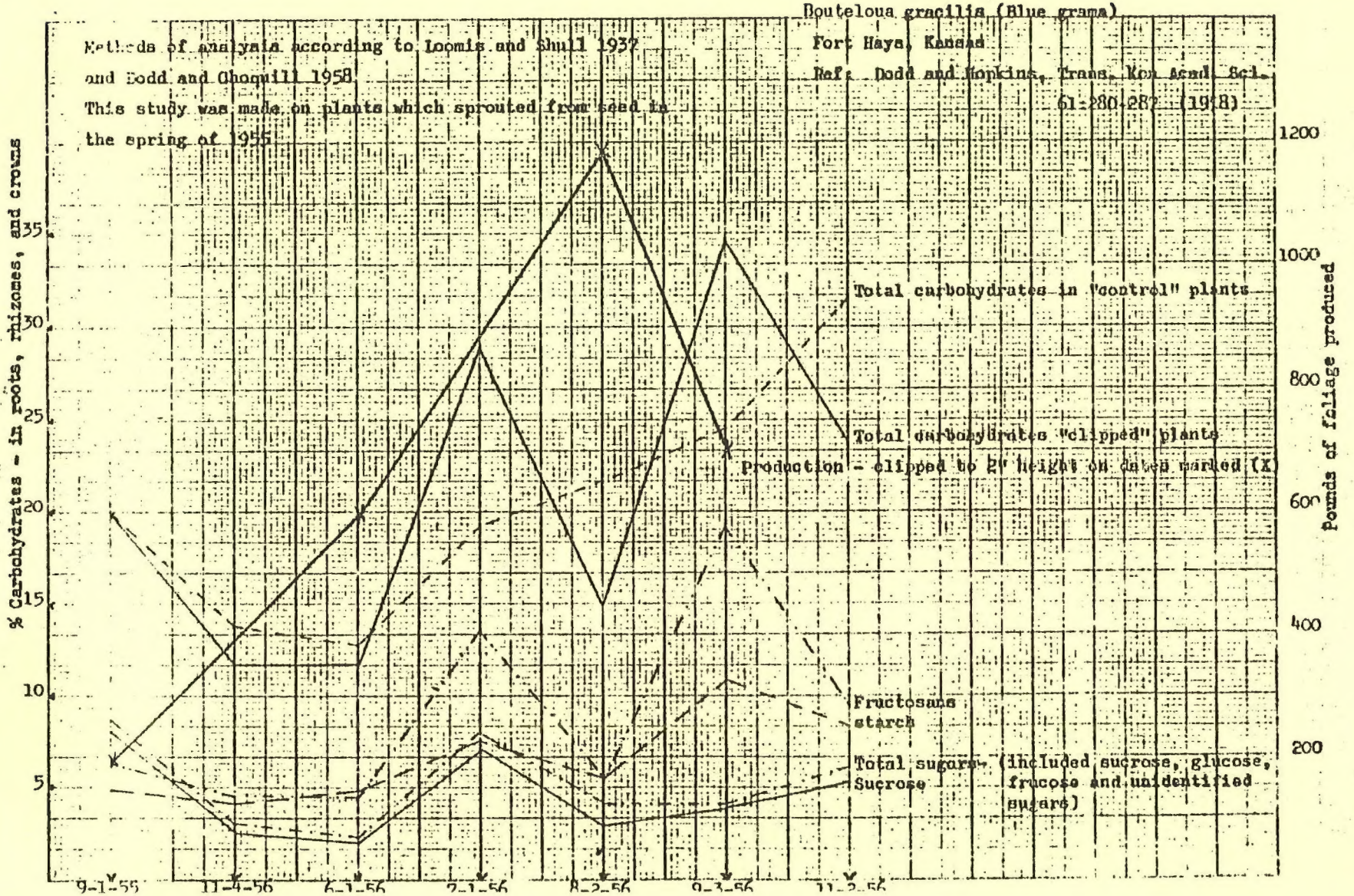
2. The Role of Carbohydrate Reserves in Managing Range Plants. Mimeograph Series - 499. October, 1966.

No longer stocked

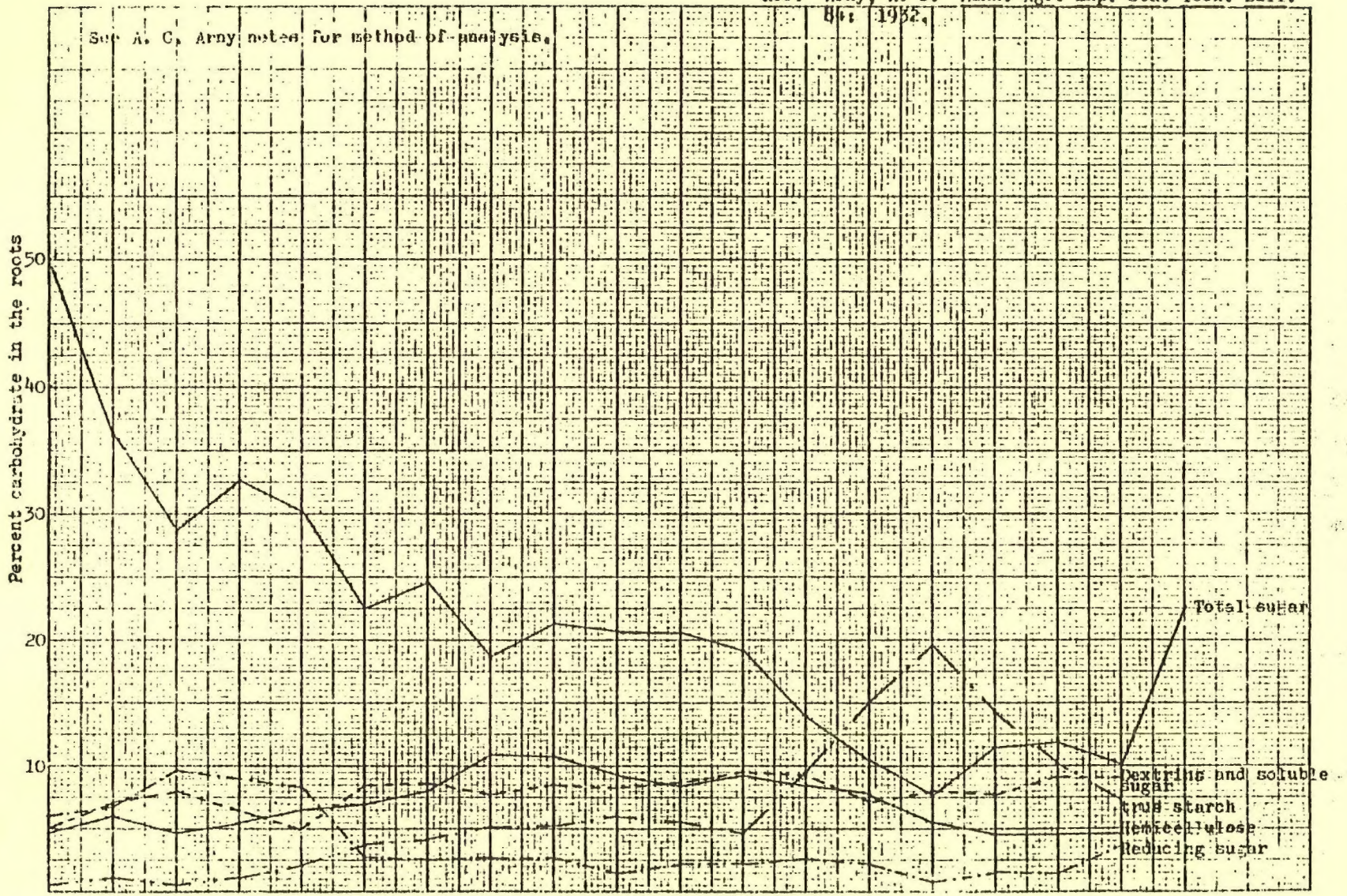
Phleum pratense
State College, Penn.
Ref: Harper & phillips, 1943. Univ. N. Hampsh. Agr. Exp. Sta. Bull. 81, 1943.

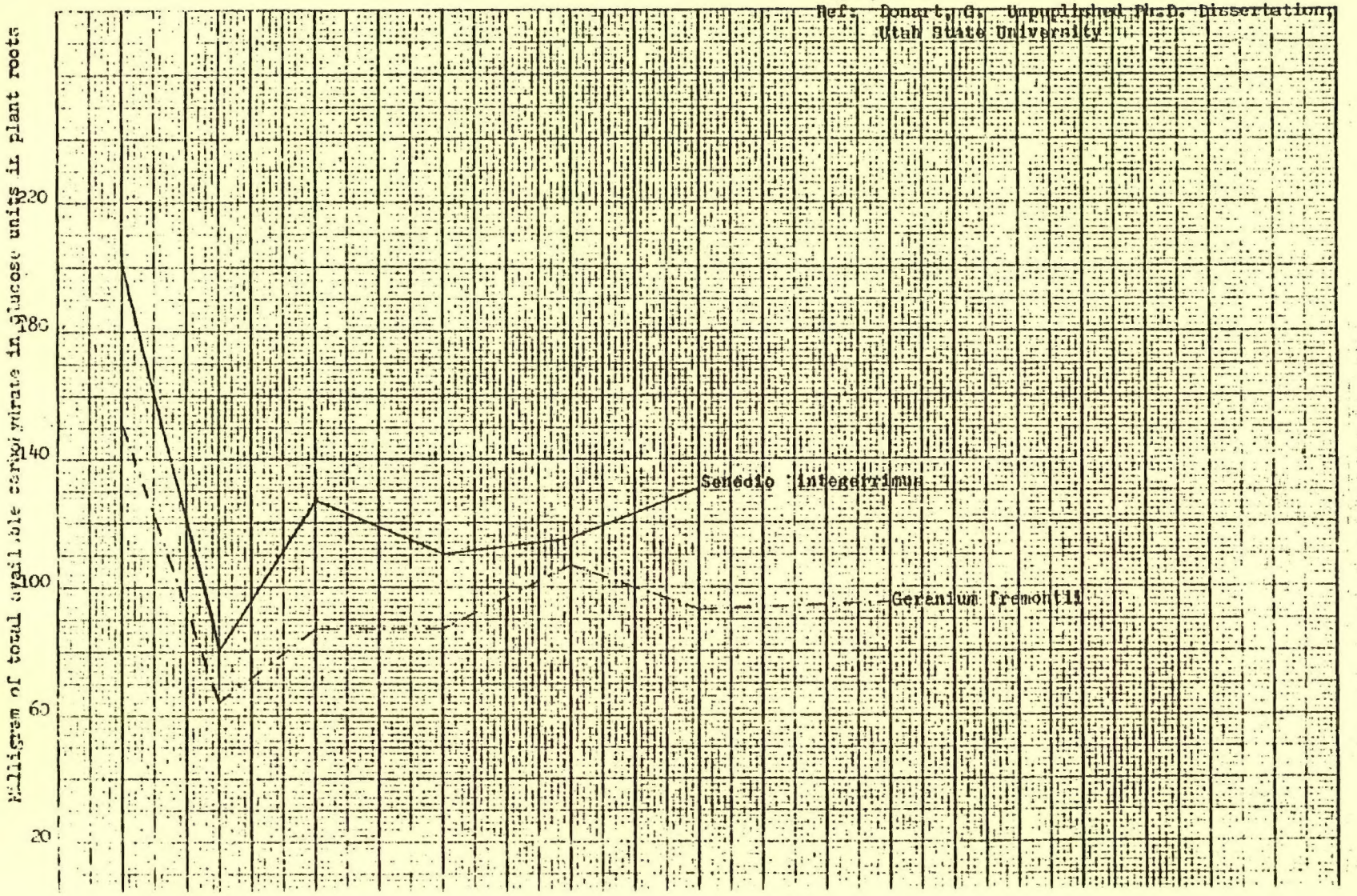


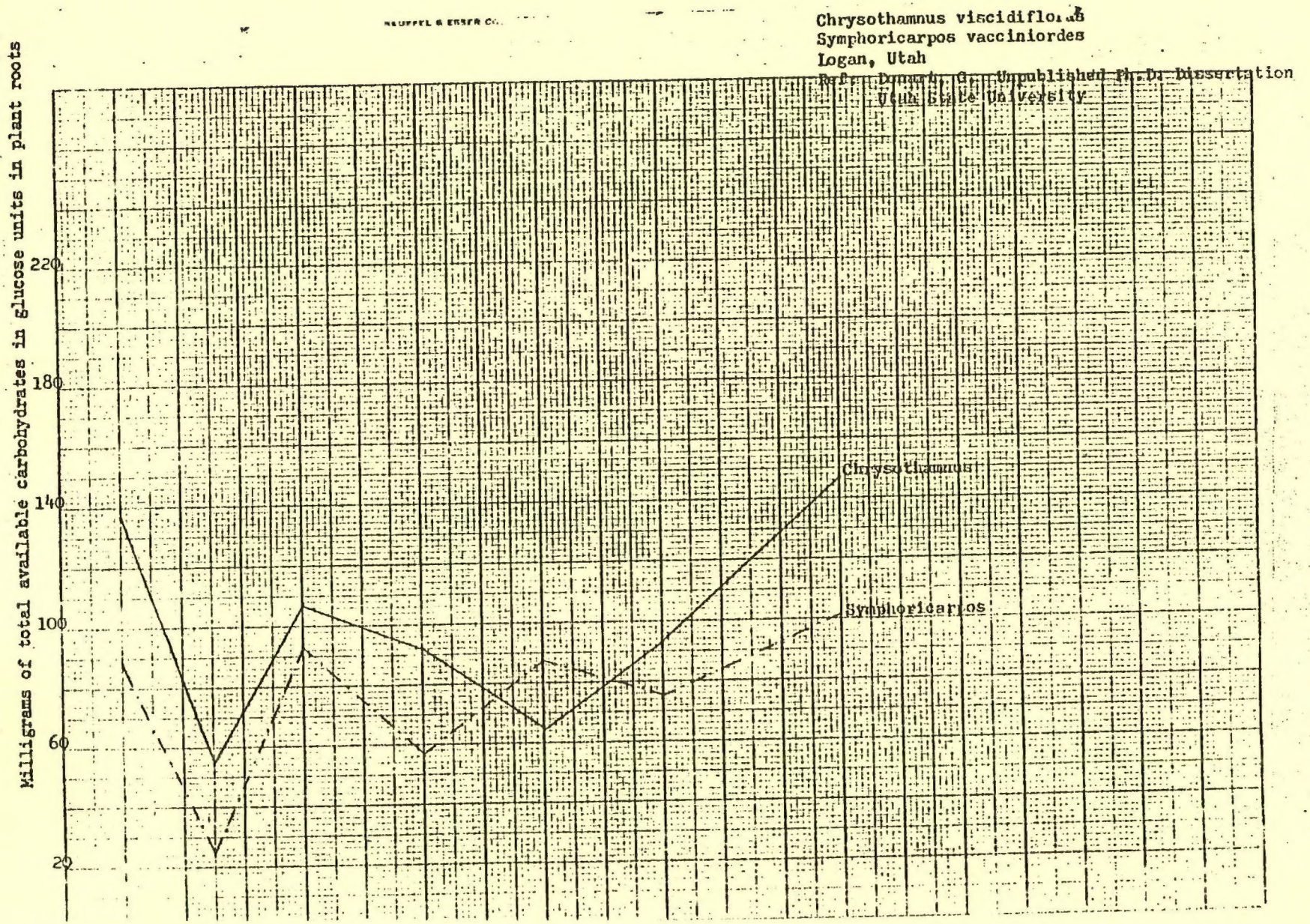

Stipa pulchra
Reducing sugars and sucrose were determined by the method of Wellaman and Davidson
Berkeley, California
Ref Samsen and McCarty, Helgardia 5:61-100 (1930)
Polysaccharides by Thomas and Dutcher Method
% Carbohydrates in plant roots
8
6
4
2
0
Total carbohydrates (reducing sugars, sucrose and polysaccharides)
Sucrose
Reducing sugars
% Total herbage growth per day
1.2
0.8
0.4
0.
Daily crown
Oct 14
Nov 13
Dec 13
Jan 12
Feb 11
Mar 13
Apr 12
May 12

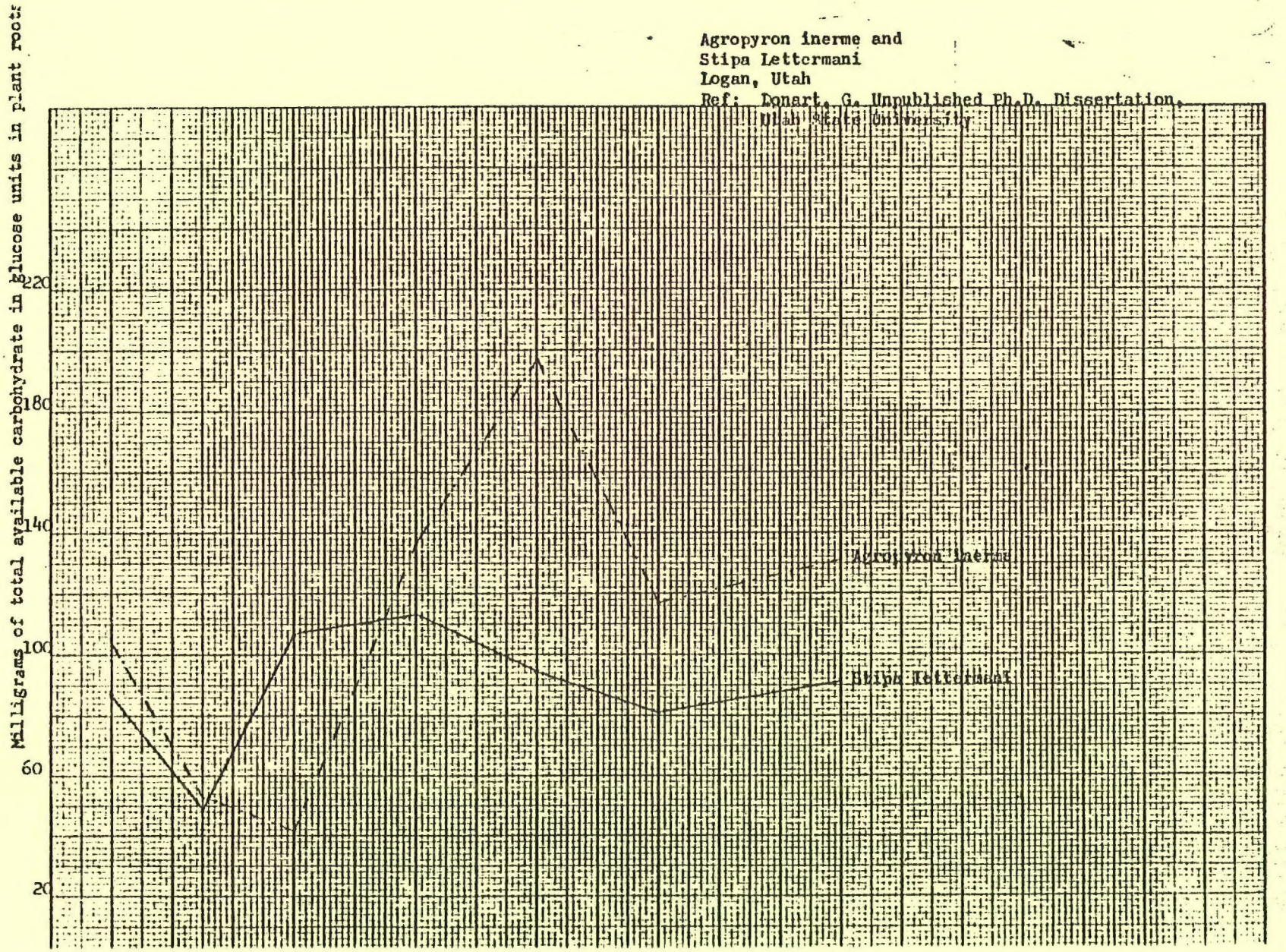

Bouteloua gracilis (Blue grama)
Fort Hays, Kansas
Ref: Dodd and Hopkins, Trans. Kan Acad. Sci. 61-280-287 (1958)
Methods of analysis according to Loomis and Shull 1937 and Dodd and Choquill 1958
This study was made on plants which sprouted from seed in the spring of 1955
% Carbohydrates - in roots, rhizomes, and crowns
Pounds of foliage produced
Total carbohydrates in "control" plants
Total carbohydrates "clipped" plants
Production - clipped to 2" height on dates marked (X)
Fructosans
starch
Total sugars (included sucrose, glucose, fructose and unidentified sugars)
Sucrose
9-1-55
11-4-56
6-1-56
2-1-56
8-2-56
9-3-56
11-2-56

Sonchus arvensis
Wash. County, Minn.
Ref: Army, A. C. Minn. Agr. Exp. Sta. Tech. Bull. 84: 1932.

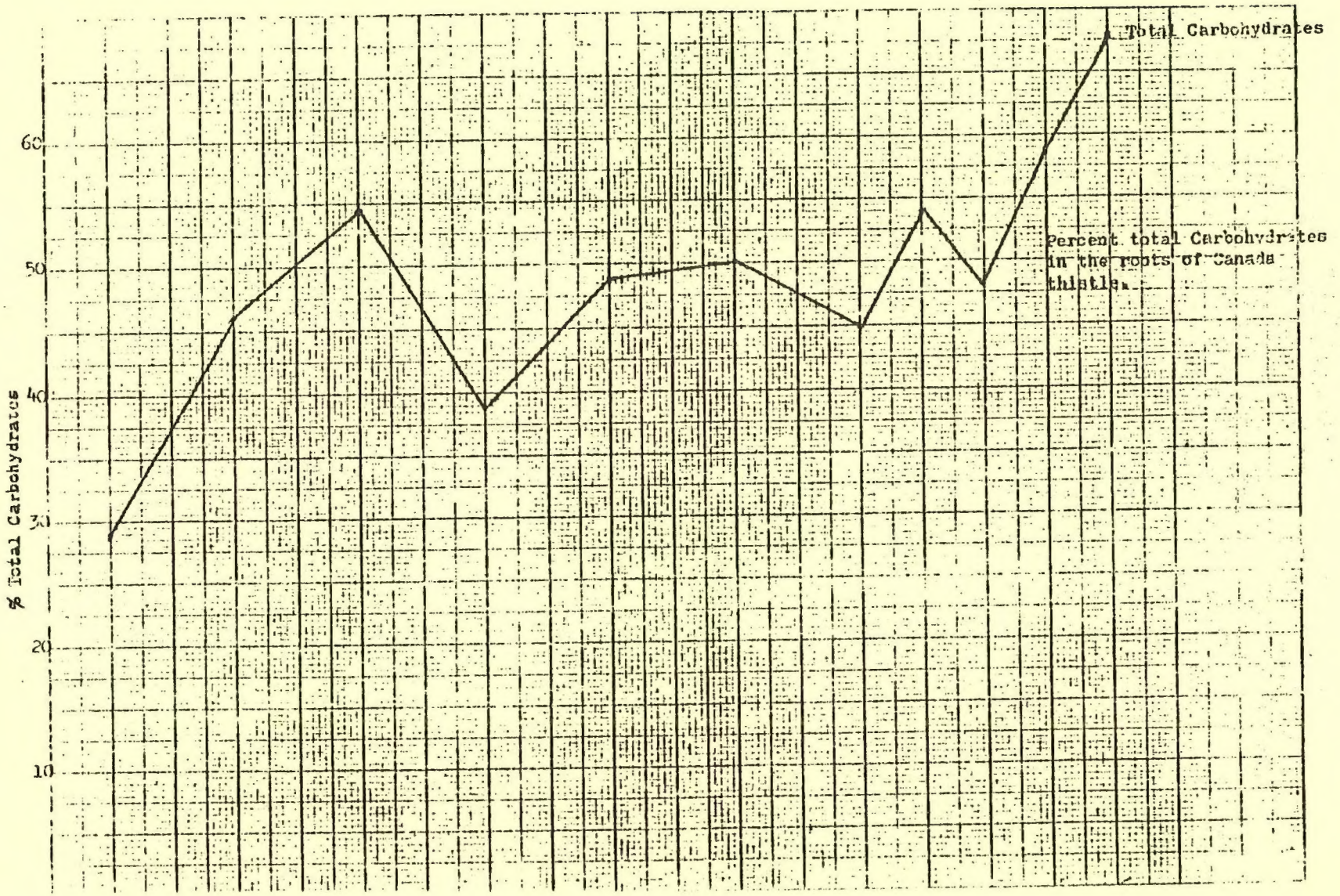



Senecio integerrimus
Geranium fremontii
Logan, Utah
Ref. Donart, G. Unpublished Ph.D. Dissertation, Utah State University
Milligram of total available carbohydrate in glucose units in plant roots
220
180
140
100
60
20
Senecio integerrimus
Geranium fremontii


Chrysothamnus viscidiflorus
Symphoricarpos vacciniordes
Logan, Utah
Ref: Dumark, G. Unpublished Ph.D. dissertation
Utah State University
Milligrams of total available carbohydrates in glucose units in plant roots
220
180
140
100
60
20
Chrysothamnus
Symphoricarpos

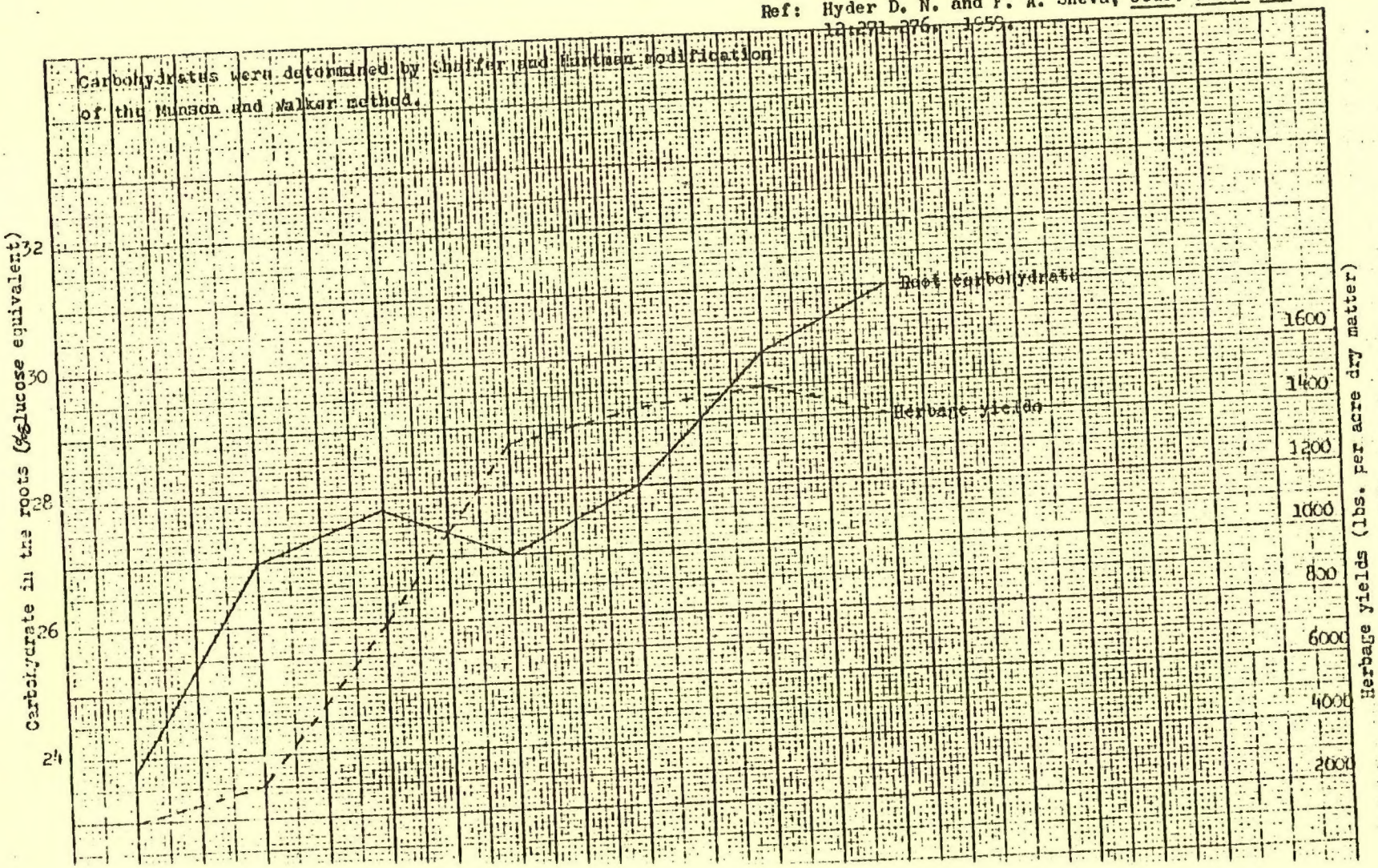

Agropyron inerme and
Stipa Lettermani
Logan, Utah
Ref: Donart, G. Unpublished Ph.D. Dissertation,
Utah State University
Milligrams of total available carbohydrate in glucose units in plant roots
220
180
140
100
60
20
Agropyron inerme
Stipa Lettermani

Rogers, Charles F.
M. S. Thesis (1925)

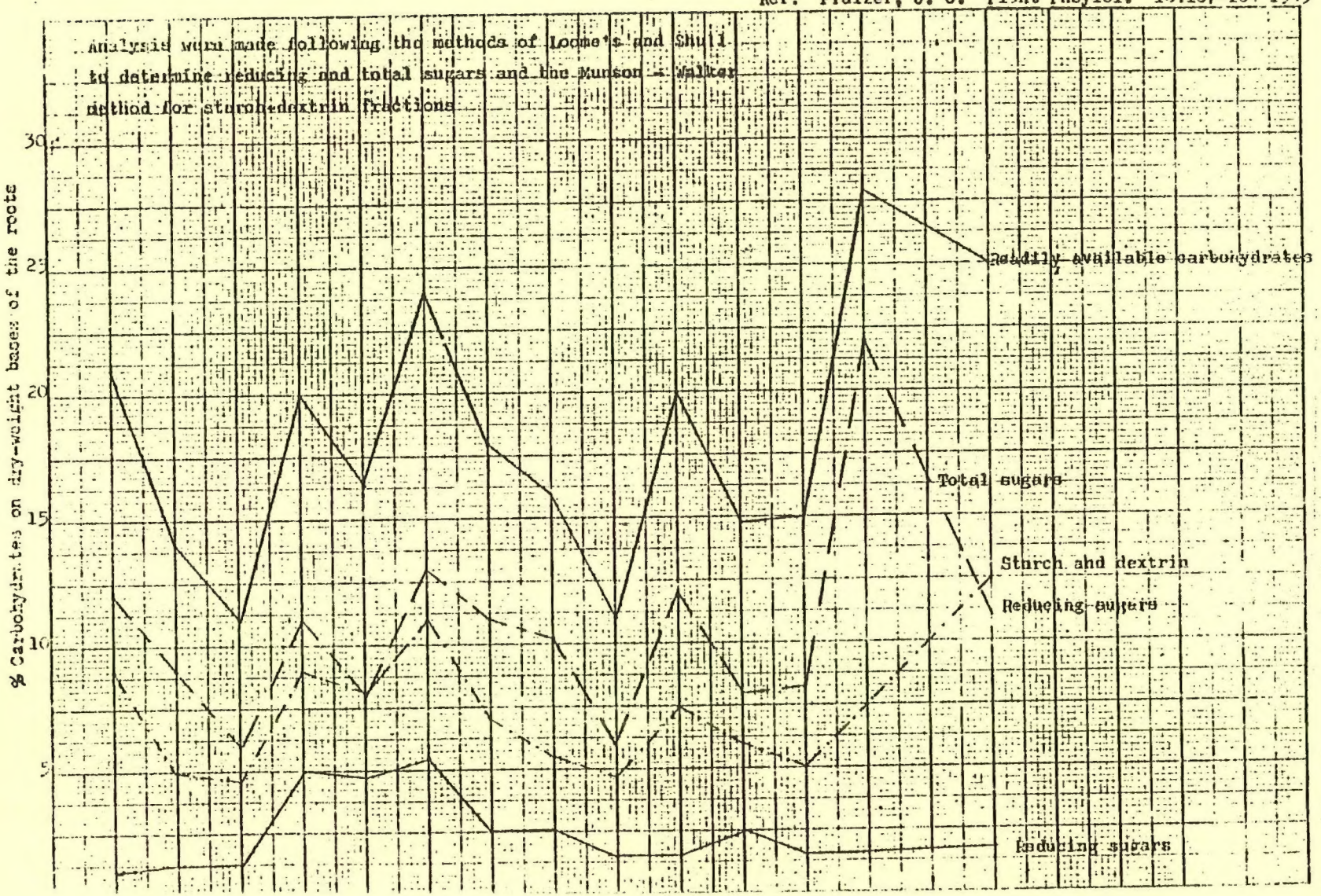


Agropyron desertorum
Squaw Butte Range Oregon
Ref: Hyder D. N. and F. A. Sneva, Jour. Range Mgt. 12:271-276, 1959.

Carbohydrates were determined by Shaffer and Hartmann modification of the Munson and Walker method.

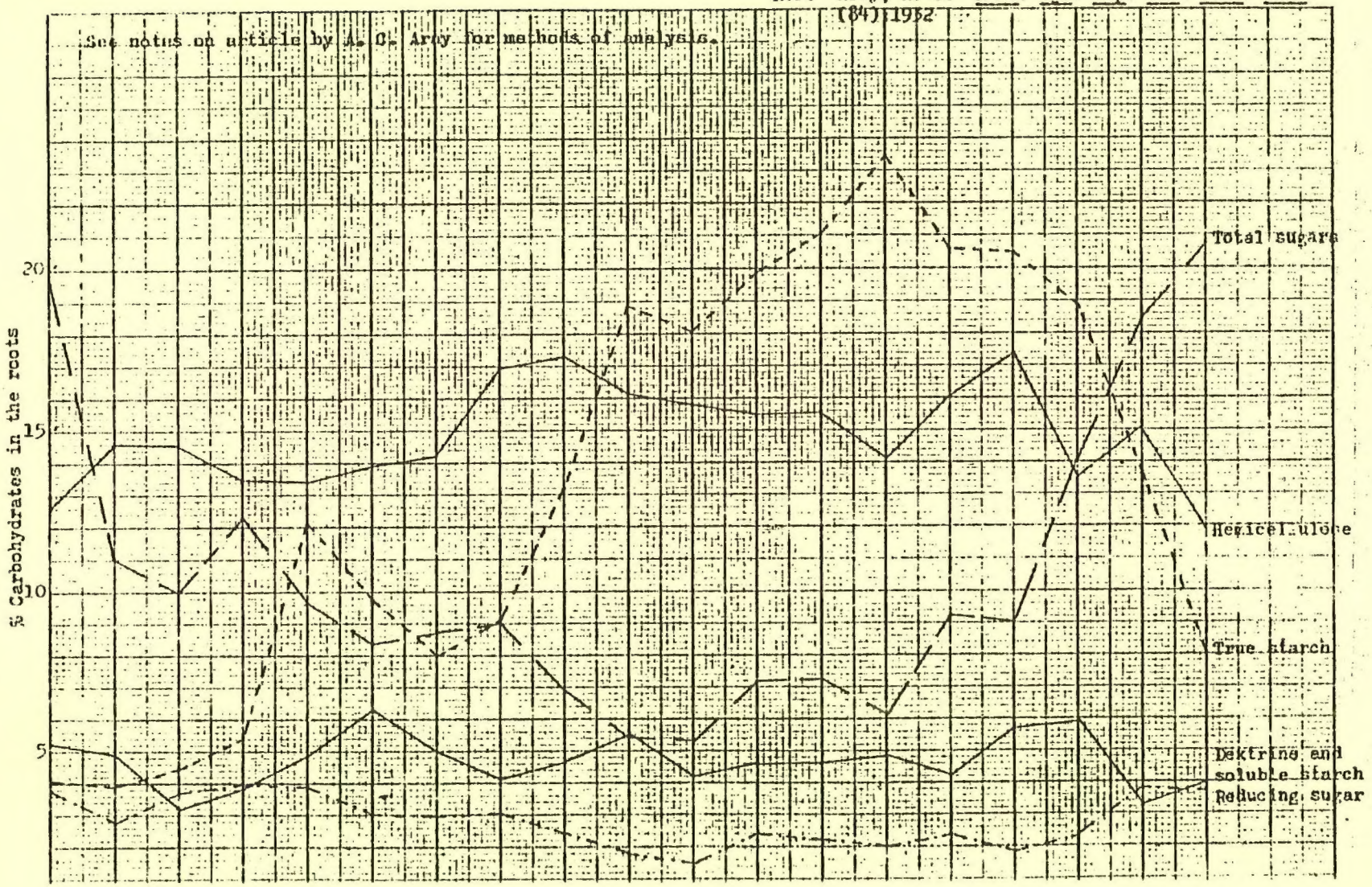


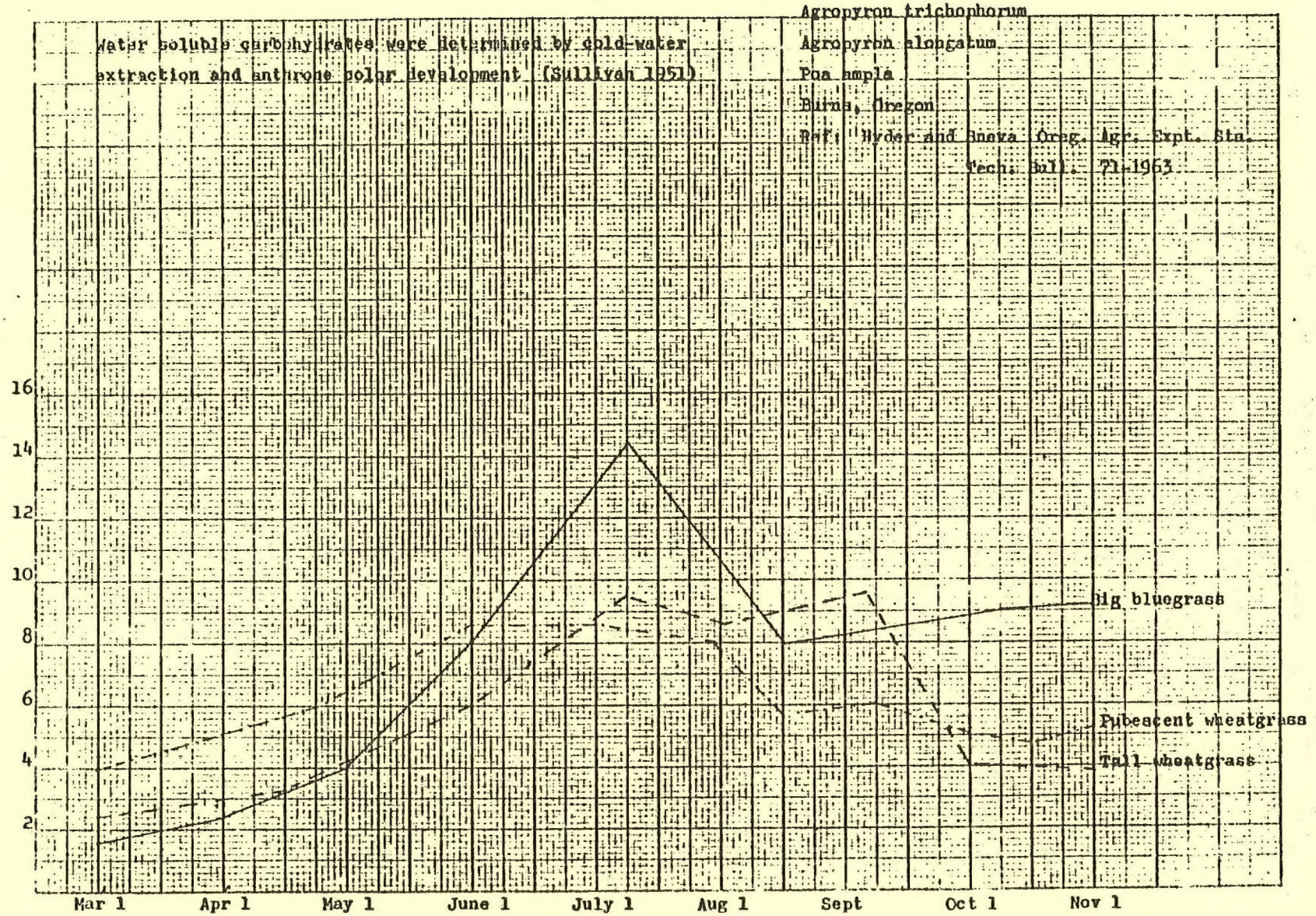
Convolvulus arvensis
Hays, Kansas
Ref: Fraizer, J. C. Plant Physiol. 18:167-184 1943

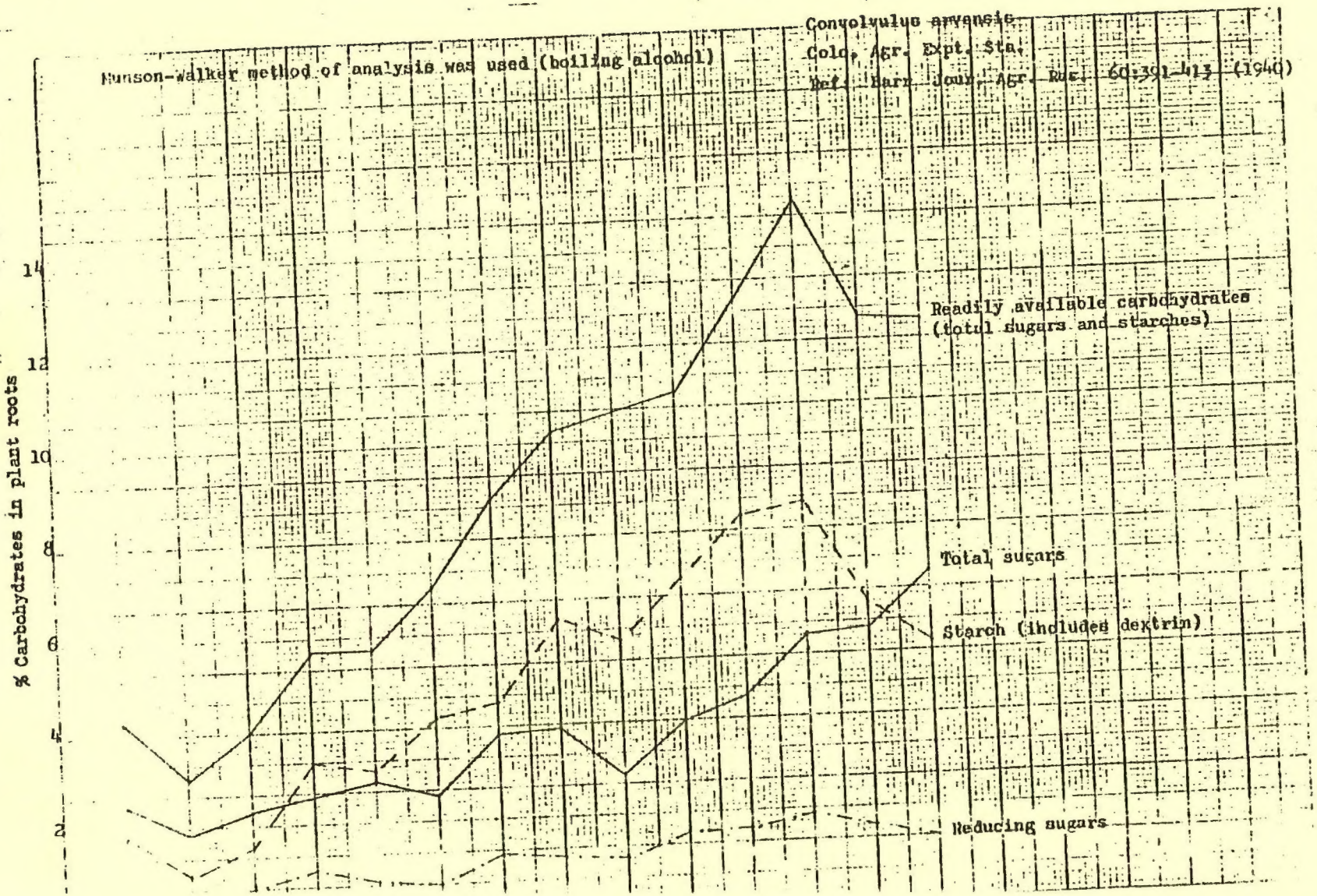


Euphorbia esula
Wash. County, Minn.
Ref: Arny, A. C. Minn. Agr. Exp. Sta. Tech. Bull. (84) 1932

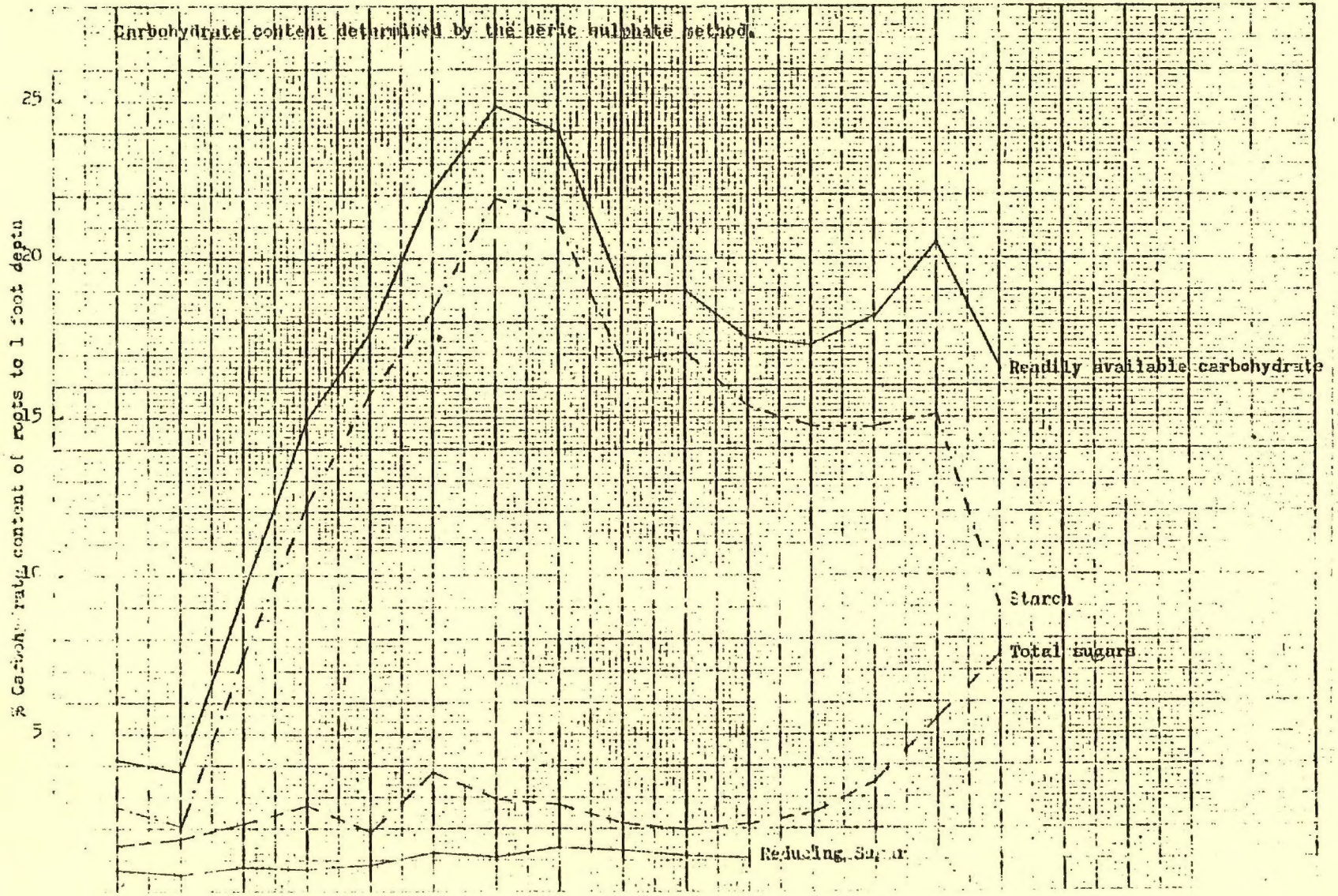
See notes on article by A. C. Arny for methods of analysis.

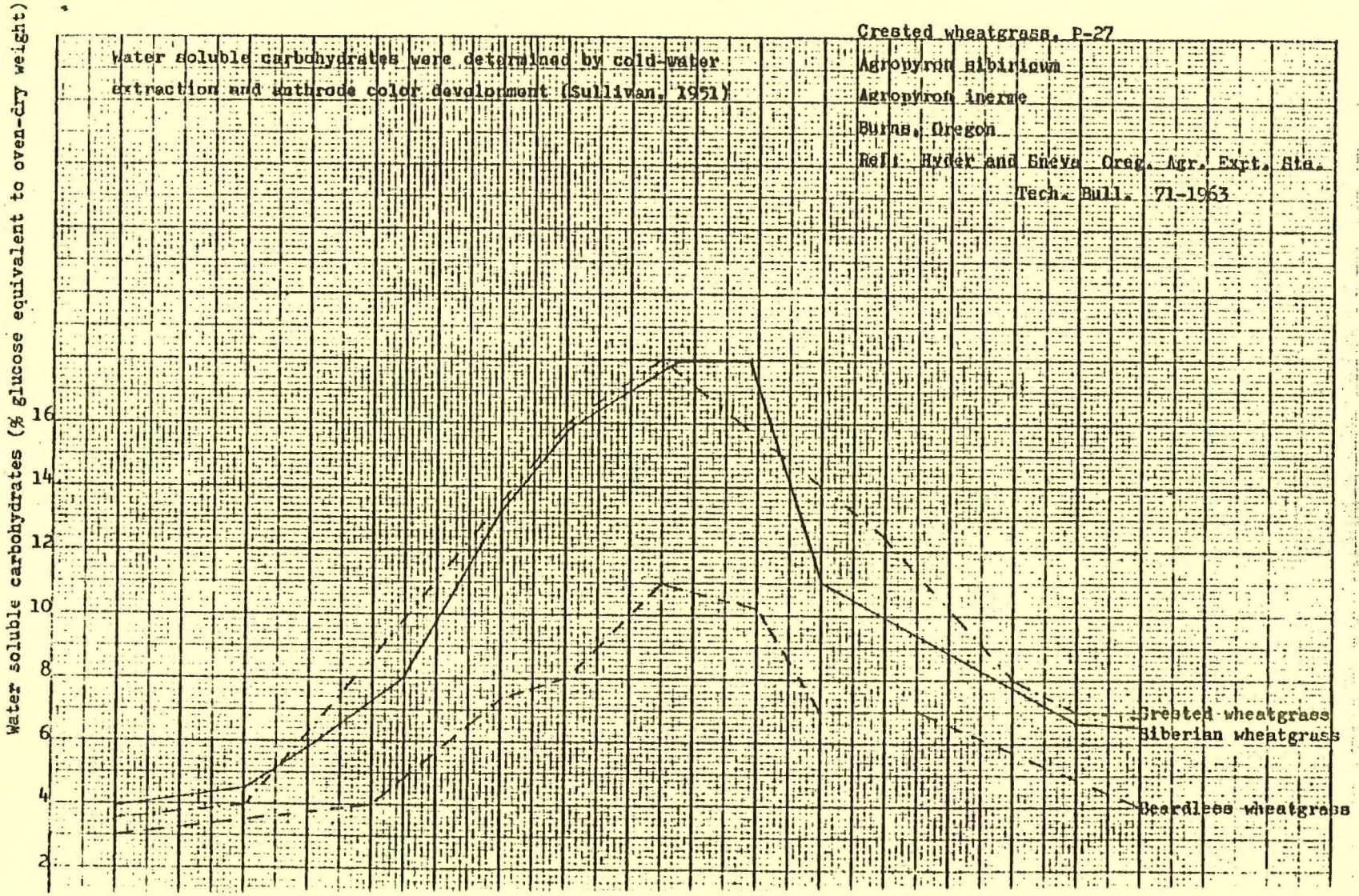


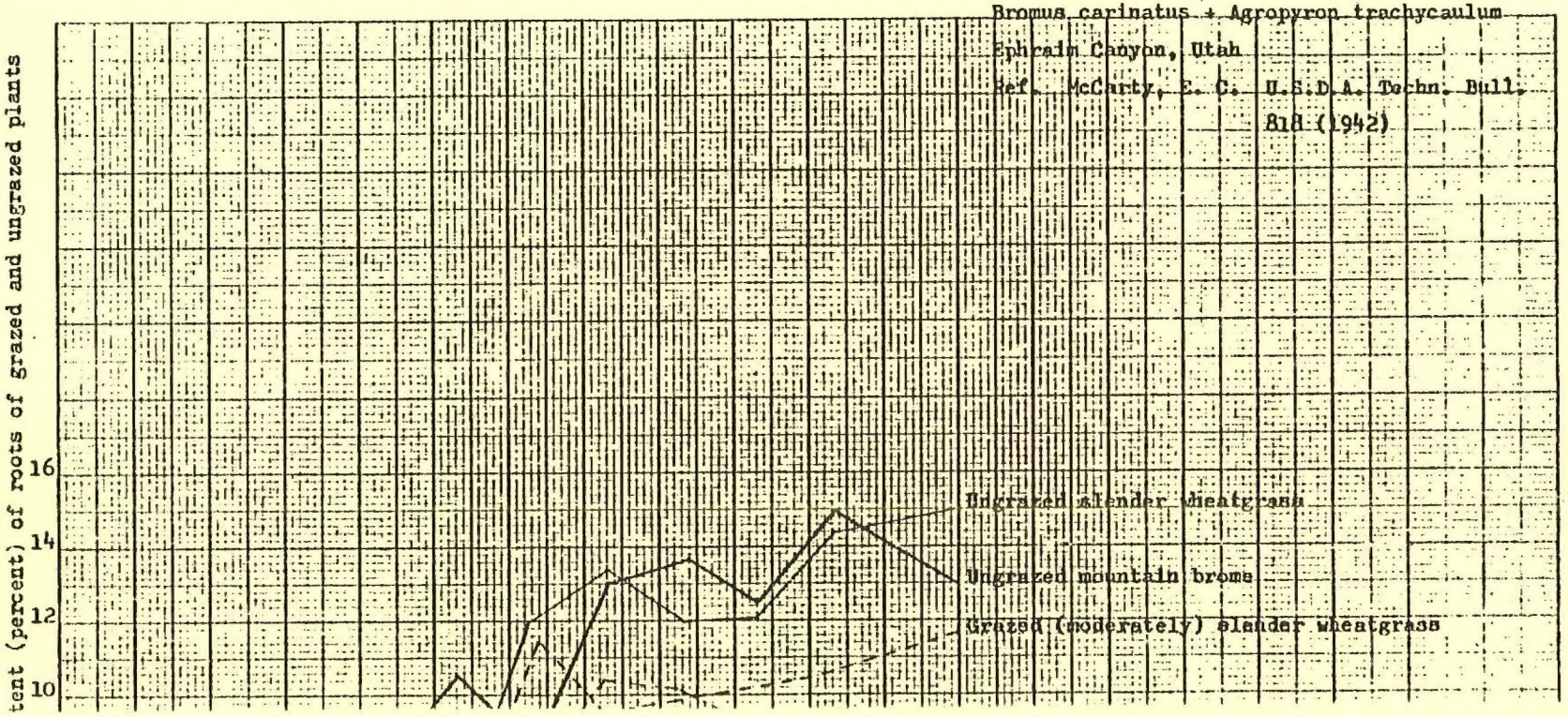

Water soluble carbohydrates were determined by cold-water extraction and anthrone color development (Sullivan 1951)
Agropyron trichophorum
Agropyron elongatum
Poa ampla
Burns, Oregon
Ref: Hyder and Sneva Oreg. Agr. Expt. Sta. Tech. Bull. 71-1963
16
14
12
10
8
6
4
2
Mar 1
Apr 1
May 1
June 1
July 1
Aug 1
Sept
Oct 1
Nov 1
Big bluegrass
Pubescent wheatgrass
Tall wheatgrass


Convolvulus arvensis
Munson-walker method of analysis was used (boiling alcohol)
Colo. Agr. Expt. Sta.
Ref. Harn. Jour. Agr. Res. 60:391-413 (1940)
% Carbohydrates in plant roots
14
12
10
8
6
4
2
Readily available carbohydrates (total sugars and starches)
Total sugars
Starch (includes dextrin)
Reducing sugars

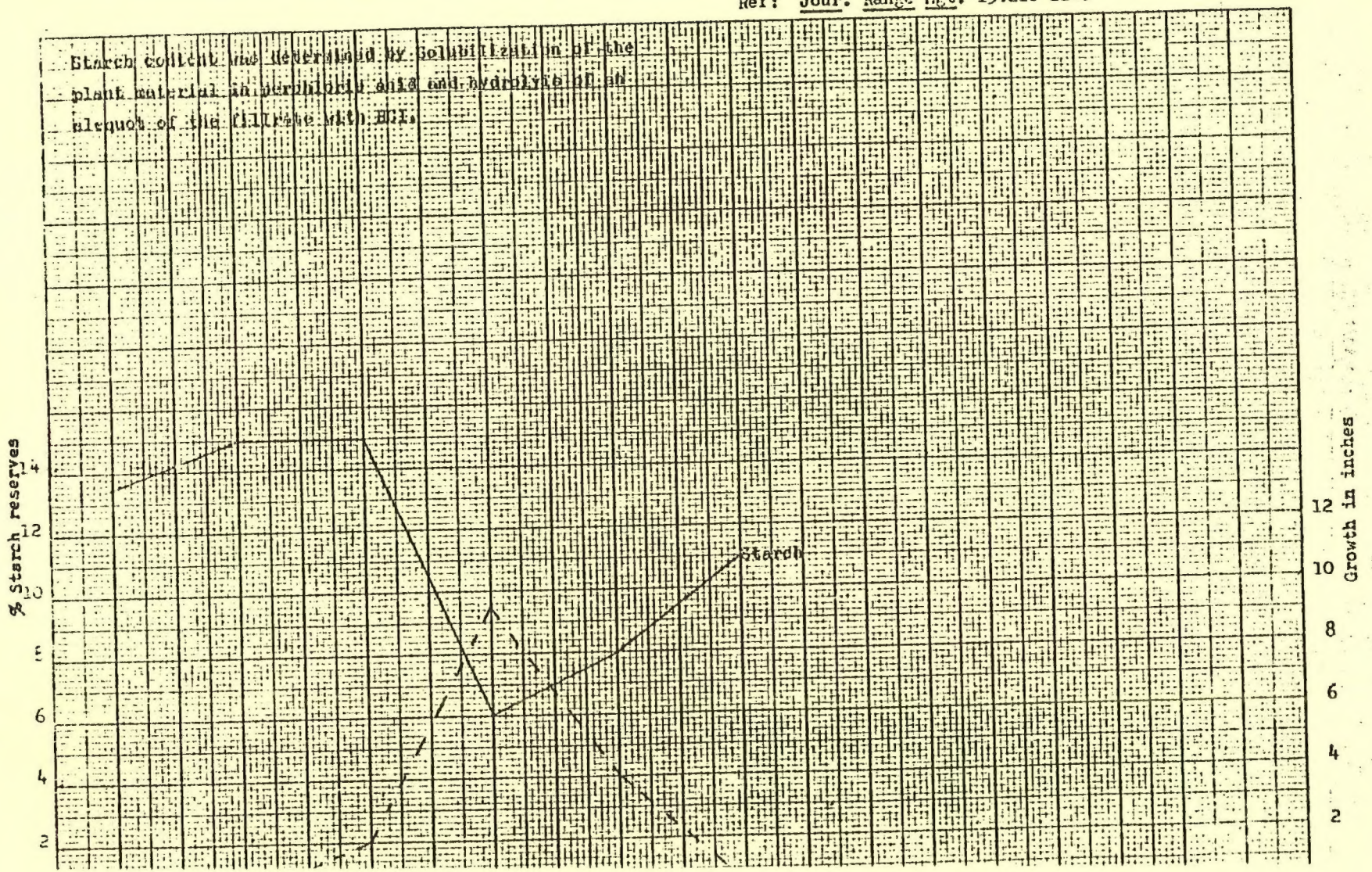
Cardaria draba
Colorado Expt. Sta.
Ref: Barr, C. G. Jour. Agr. Res. 64:725-740, 1942.



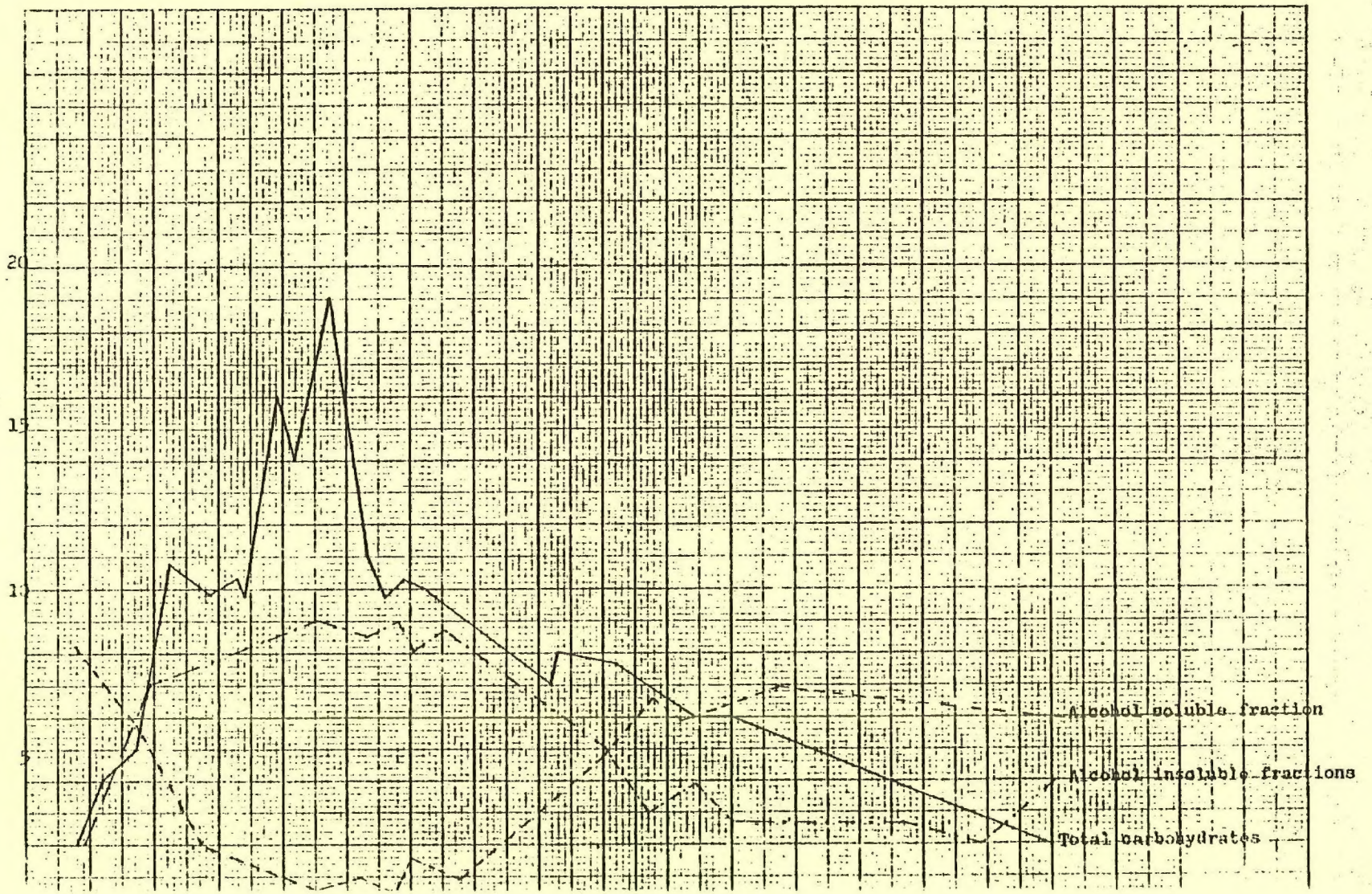

Water soluble carbohydrates were determined by cold-water extraction and anthrone color development (Sullivan, 1951)
Crested wheatgrass, P-27
Agropyron sibiricum
Agropyron inerme
Burns, Oregon
Refs: Hyder and Sneva, Oreg. Agr. Expt. Sta. Tech. Bull. 71-1963
Water soluble carbohydrates (% glucose equivalent to oven-dry weight)
16
14
12
10
8
6
4
2
Crested wheatgrass
Siberian wheatgrass
Beardless wheatgrass

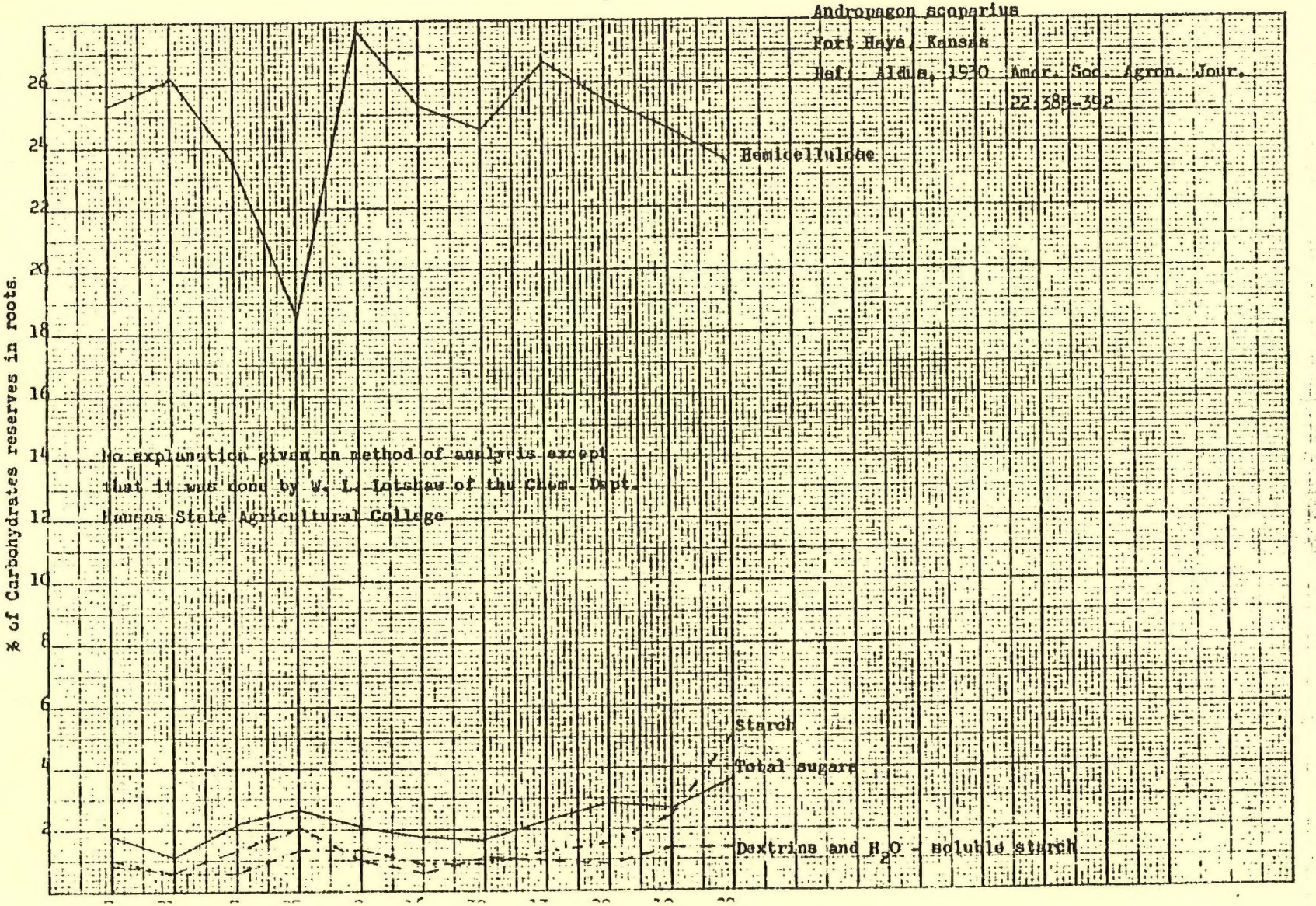

Bromus carinatus + Agropyron trachycaulum
Ephraim Canyon, Utah
Ref. McCarty, E. C. U.S.D.A. Techn. Bull. 818 (1942)
Ungrazed slender wheatgrass
Ungrazed mountain brome
Grazed (moderately) slender wheatgrass
tent (percent) of roots of grazed and ungrazed plants
16
14
12
10

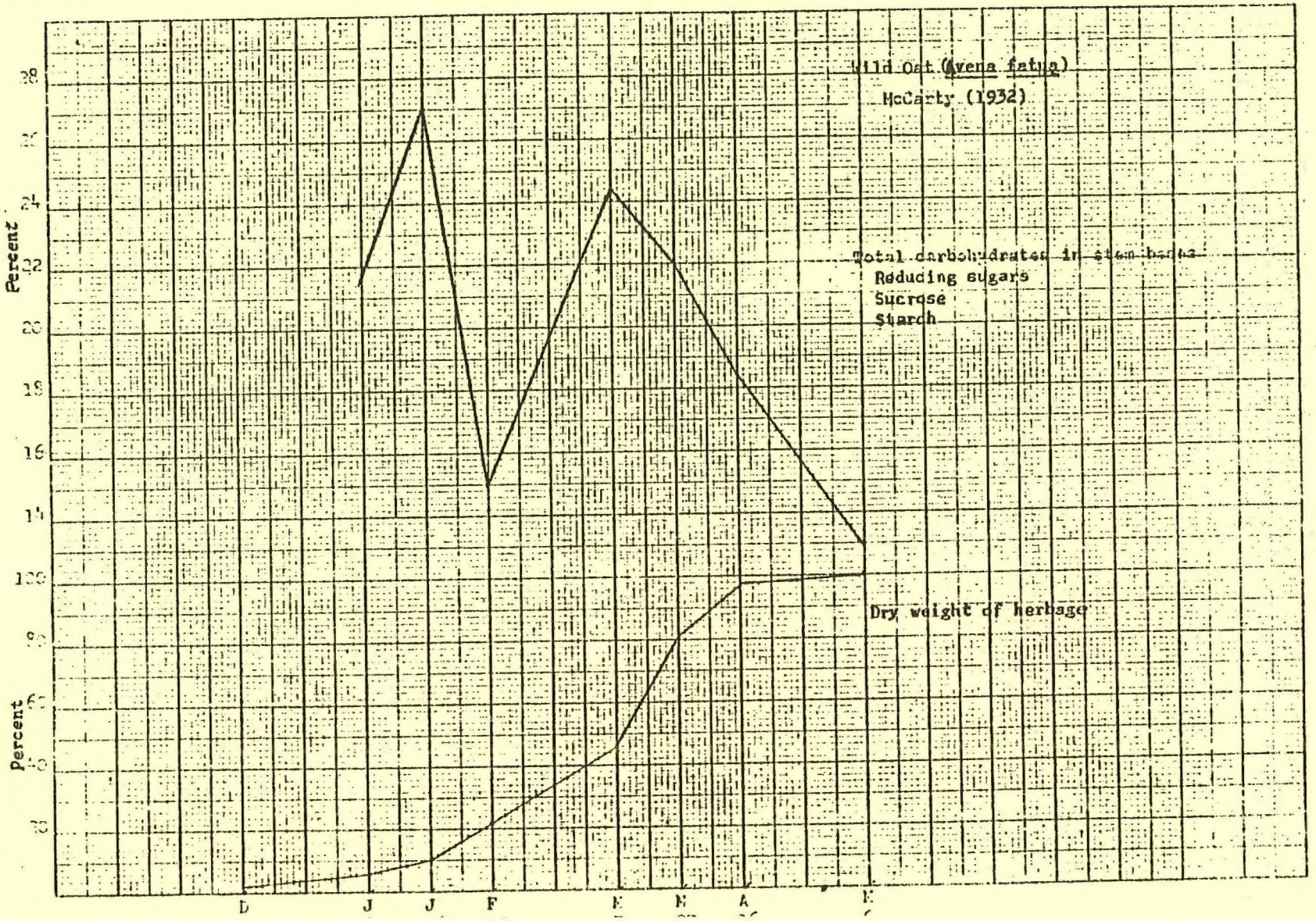
Adenostoma fasciculatum
Hopland Field Sta., California
Ref: Jour. Range Mgt. 13:210-214.

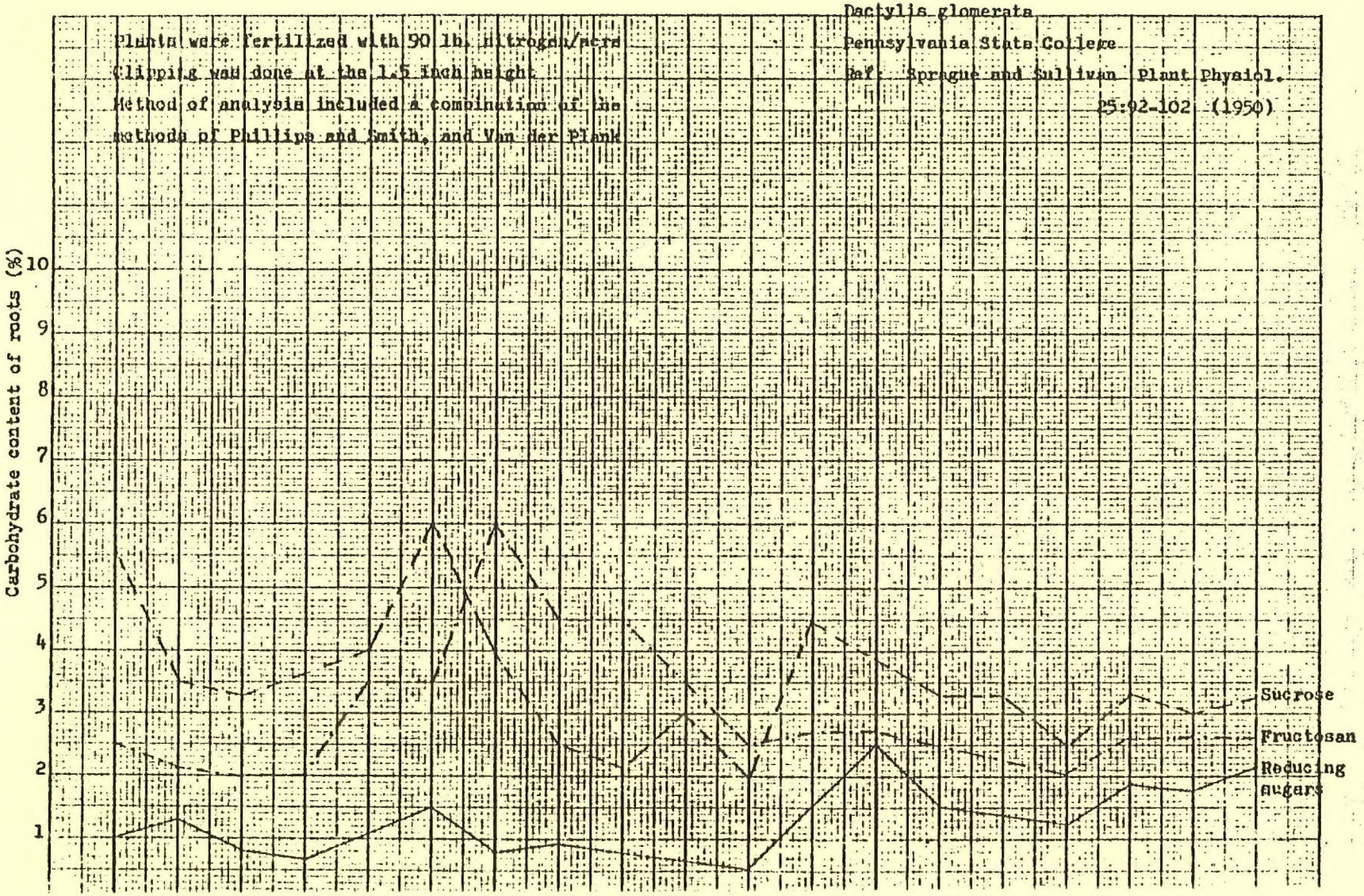


Taraxacum kok-saghyz
Kingston, Ontario
Ref: Krotkov, C. Plant Physiol. 25:169-180. 1950

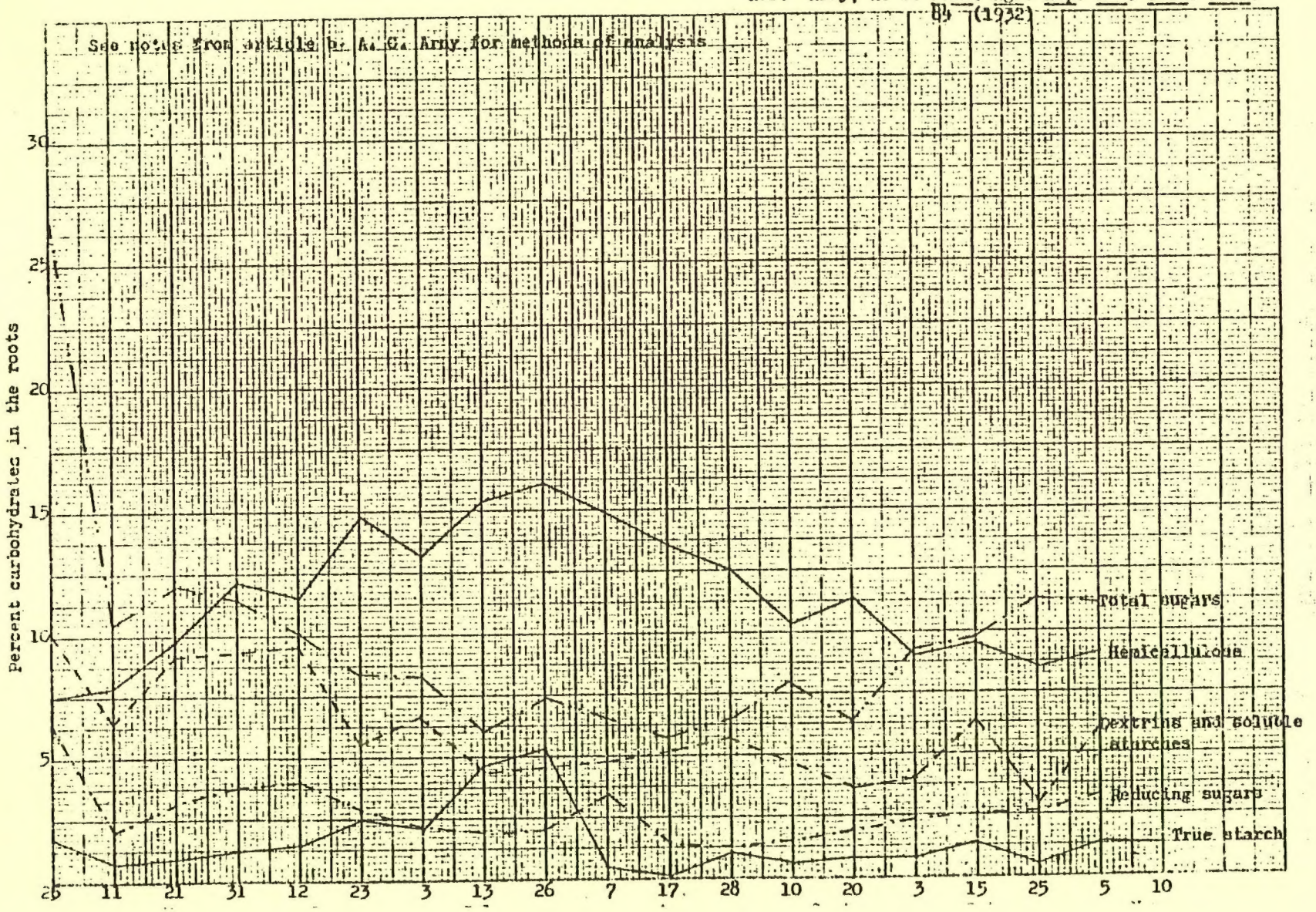



Andropagon scoparius
Fort Hays, Kansas
Ref: Alden, 1930 Amer. Soc. Agron. Jour.
22.388-392
Hemicellulose
Starch
Total sugars
Dextrins and H_2O - soluble starch
% of Carbohydrates reserves in roots
26
24
22
20
18
16
14
12
10
8
6
4
2
No explanation given on method of analysis except
that it was done by W. L. Latshaw of the Chem. Dept.
Kansas State Agricultural College


Wild Oat (Avena fatua)
McCarty (1932)
Total carbohydrates in stem bases
Reducing sugars
Sucrose
Starch
Dry weight of herbage
Percent
Percent
D
J
J
F
E
N
A
E

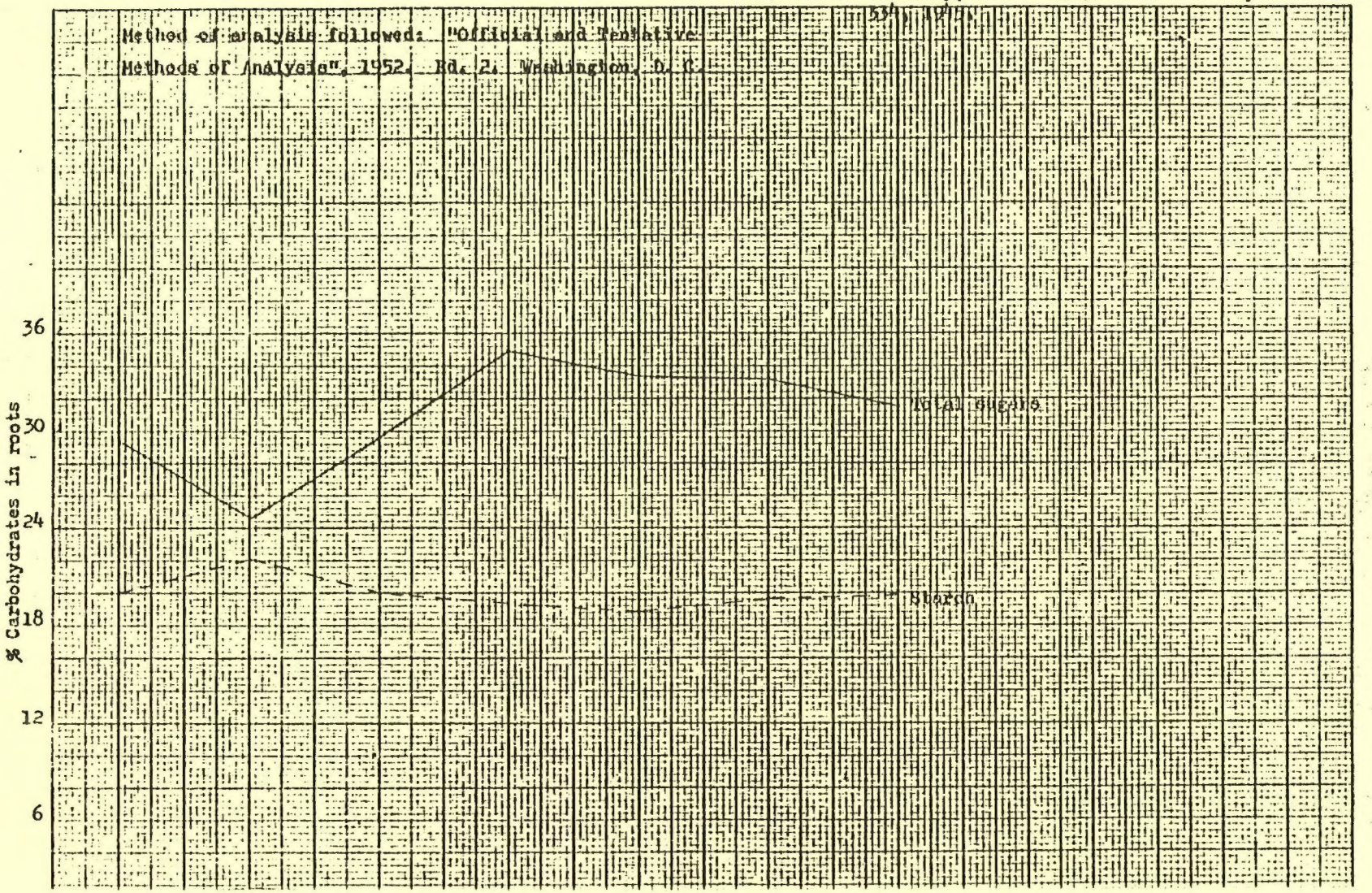

Dactylis glomerata
Pennsylvania State College
Ref: Sprague and Sullivan Plant Physiol. 25:92-102 (1950)
Plants were fertilized with 90 lb. nitrogen/acre
Clipping was done at the 1.5 inch height
Method of analysis included a combination of the methods of Phillips and Smith, and Van der Plank
Carbohydrate content of roots (%)
10
9
8
7
6
5
4
3
2
1
Sucrose
Fructosan
Reducing sugars

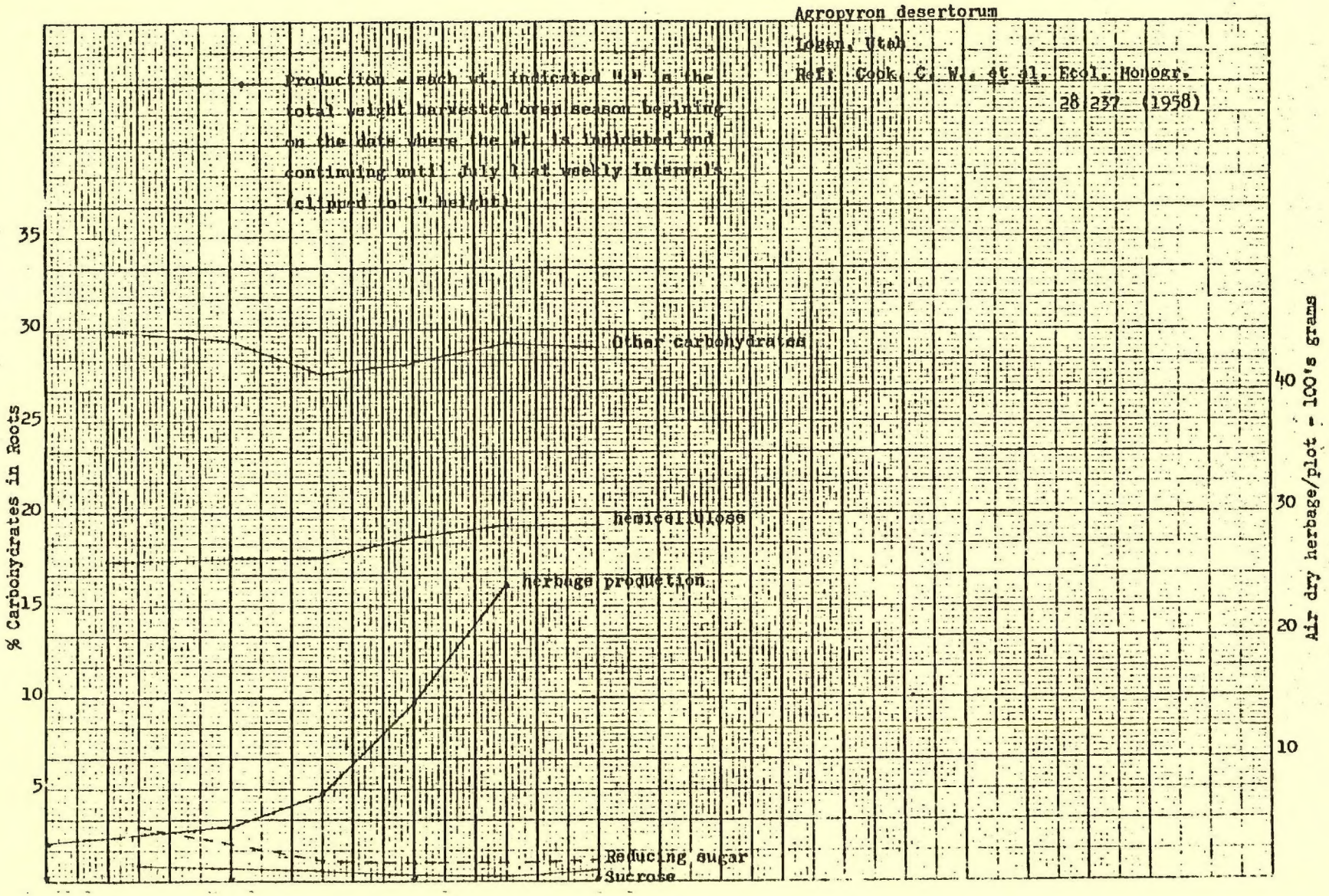
Circium arvense
Wash. County, Minn.
Ref: Arny, A. C. Minn. Agr. Exp. Sta. Tech. Bull. 89 (1932)



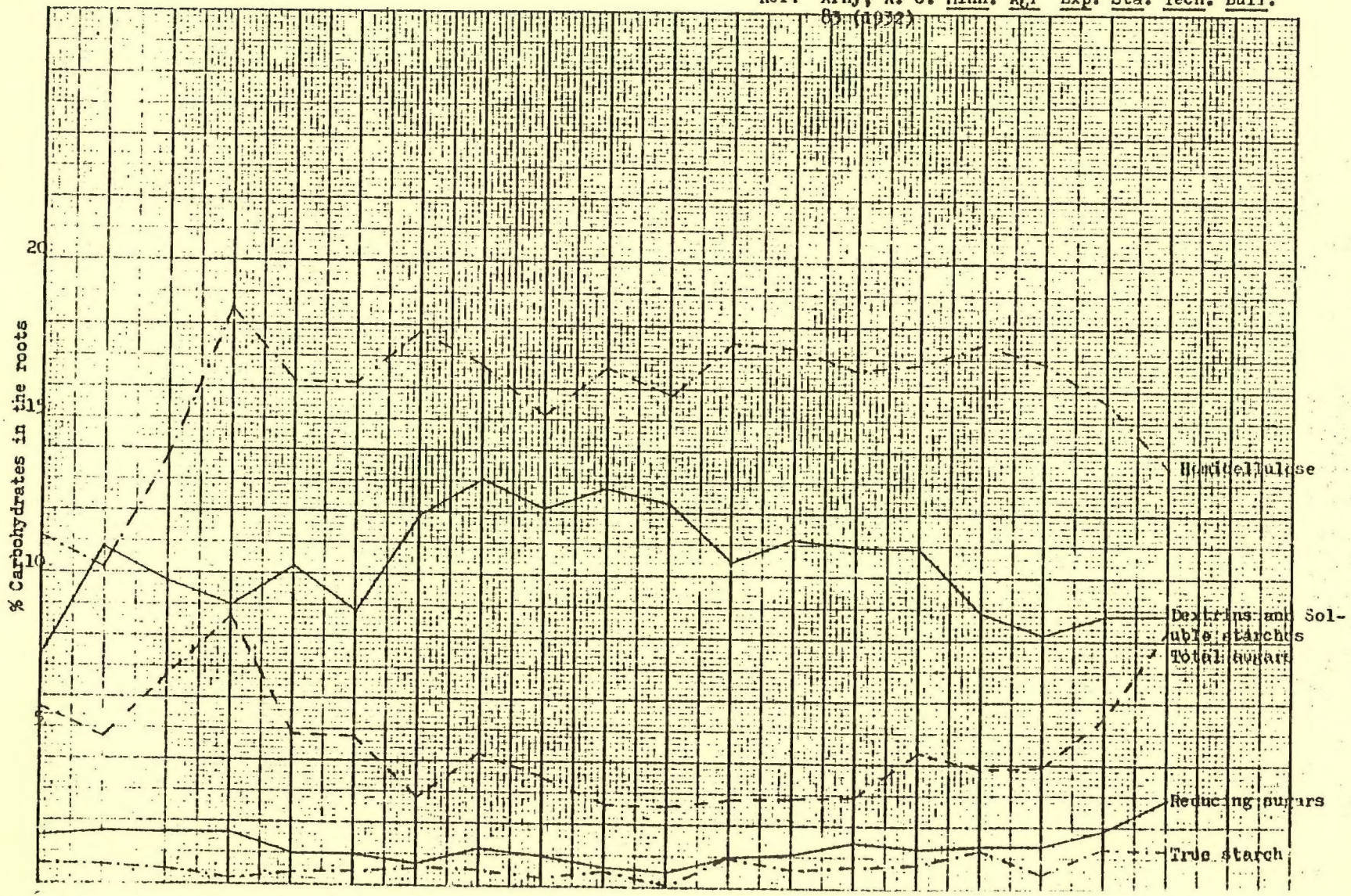
Agropyron repens
Fargo, N. Dakota
Ref: Pinckney, A. J. 1945. No. Dak. Exp. Sta. Bul. 334, 10 pp.

Method of analysis followed: "Official and Tentative Methods of Analysis", 1952, Ed. 2, Washington, D. C.

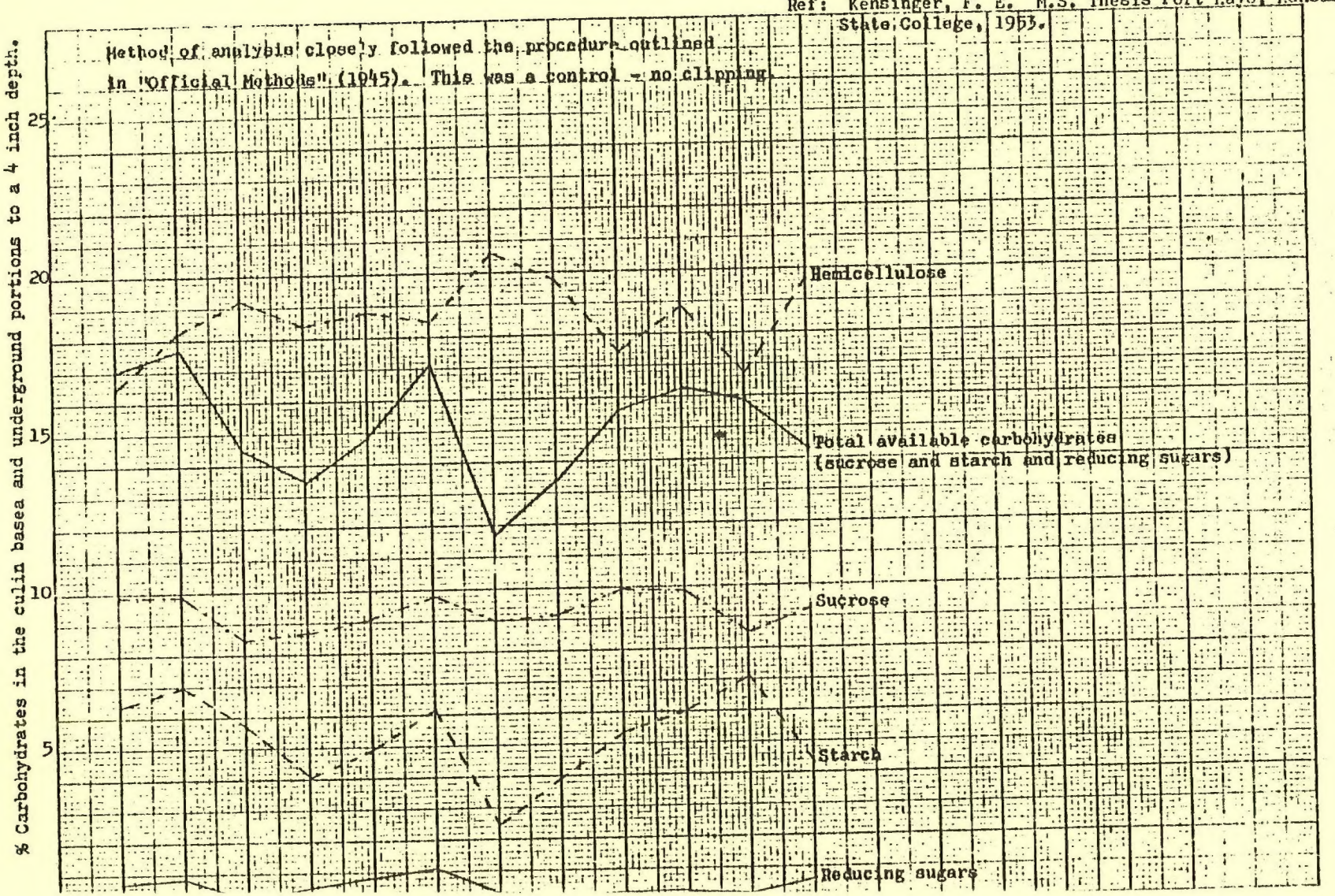



Agropyron desertorum
Logan, Utah
Ref. Cook, C. W., et al, Ecol. Monogr. 28 237 (1958)
Production = each wt. indicated "•" is the total weight harvested over season begining on the date where the wt. is indicated and continuing until July 1 at weekly intervals (clipped to 1" height)
% Carbohydrates in Roots
35
30
25
20
15
10
5
Other carbohydrates
hemicellulose
herbage production
Reducing sugar
Sucrose
40
30
20
10
Air dry herbage/plot - 100's grams

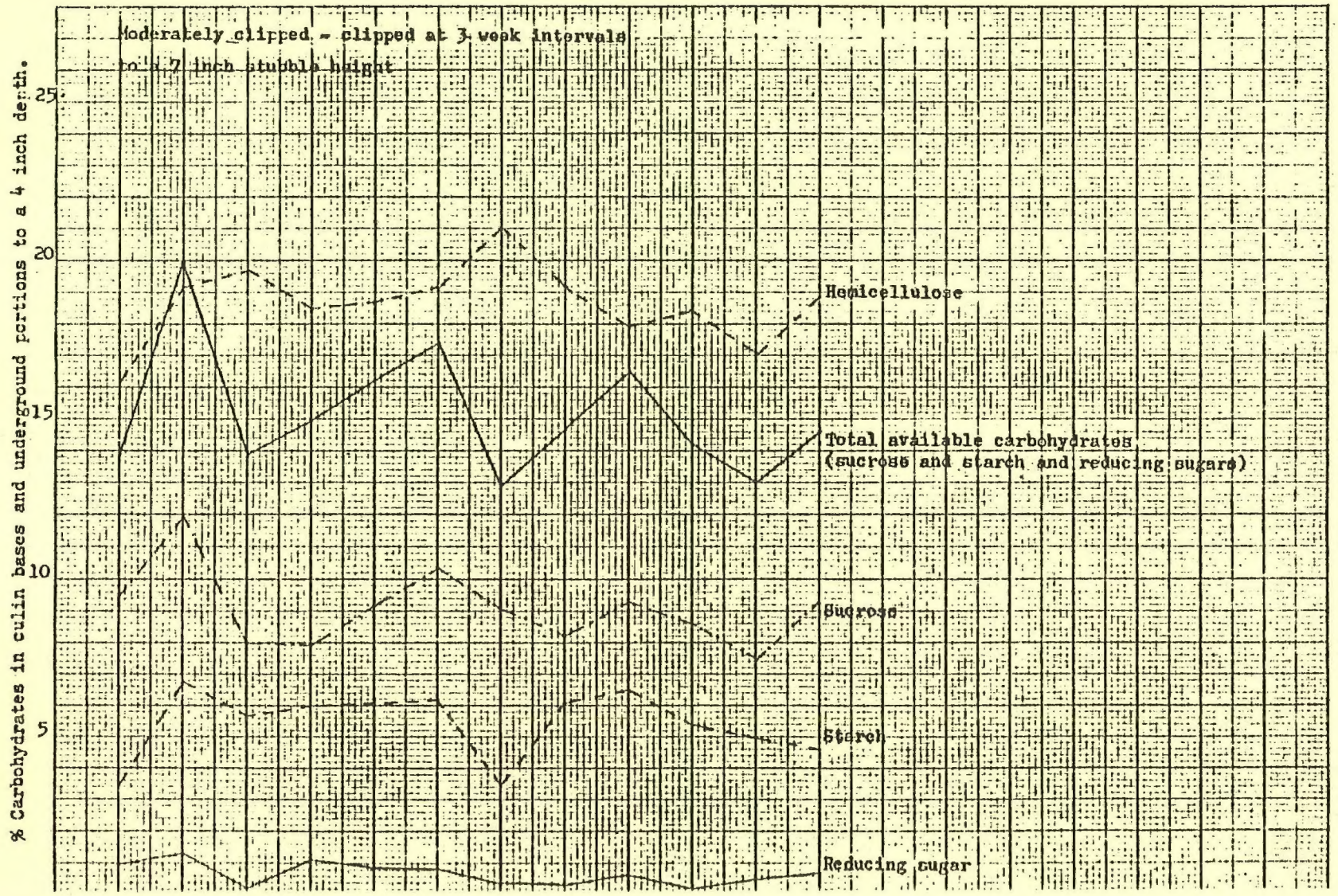
Agropyron repens
Wash. Co., Minn.
Ref: Arny, A. C. Minn. Agr Exp. Sta. Tech. Bull. 83 (1932)



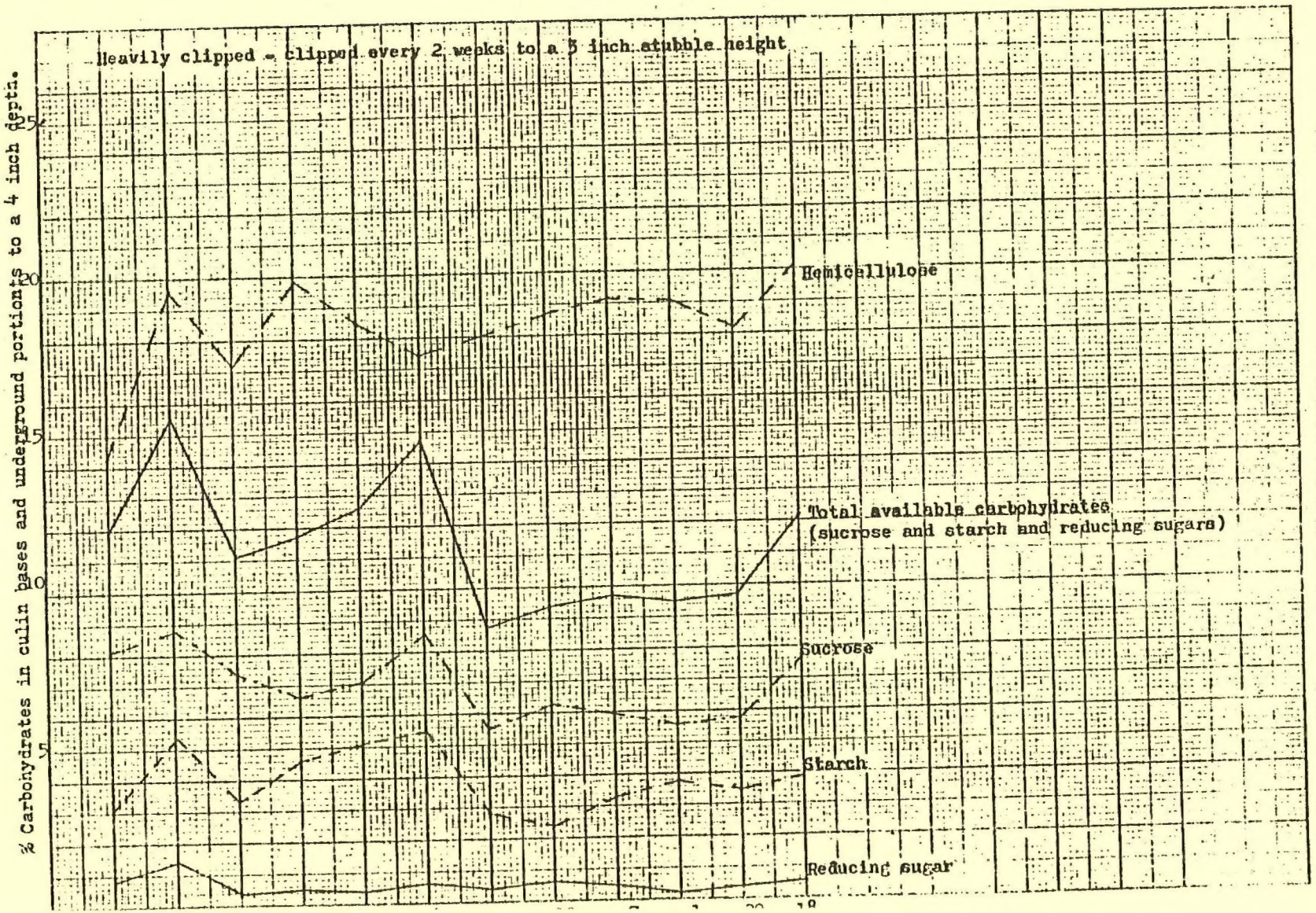
Agropyron Smithii
Fort Hays Kansas
Ref: Kensinger, F. E. M.S. Thesis Fort Hays, Kansas State College, 1953.

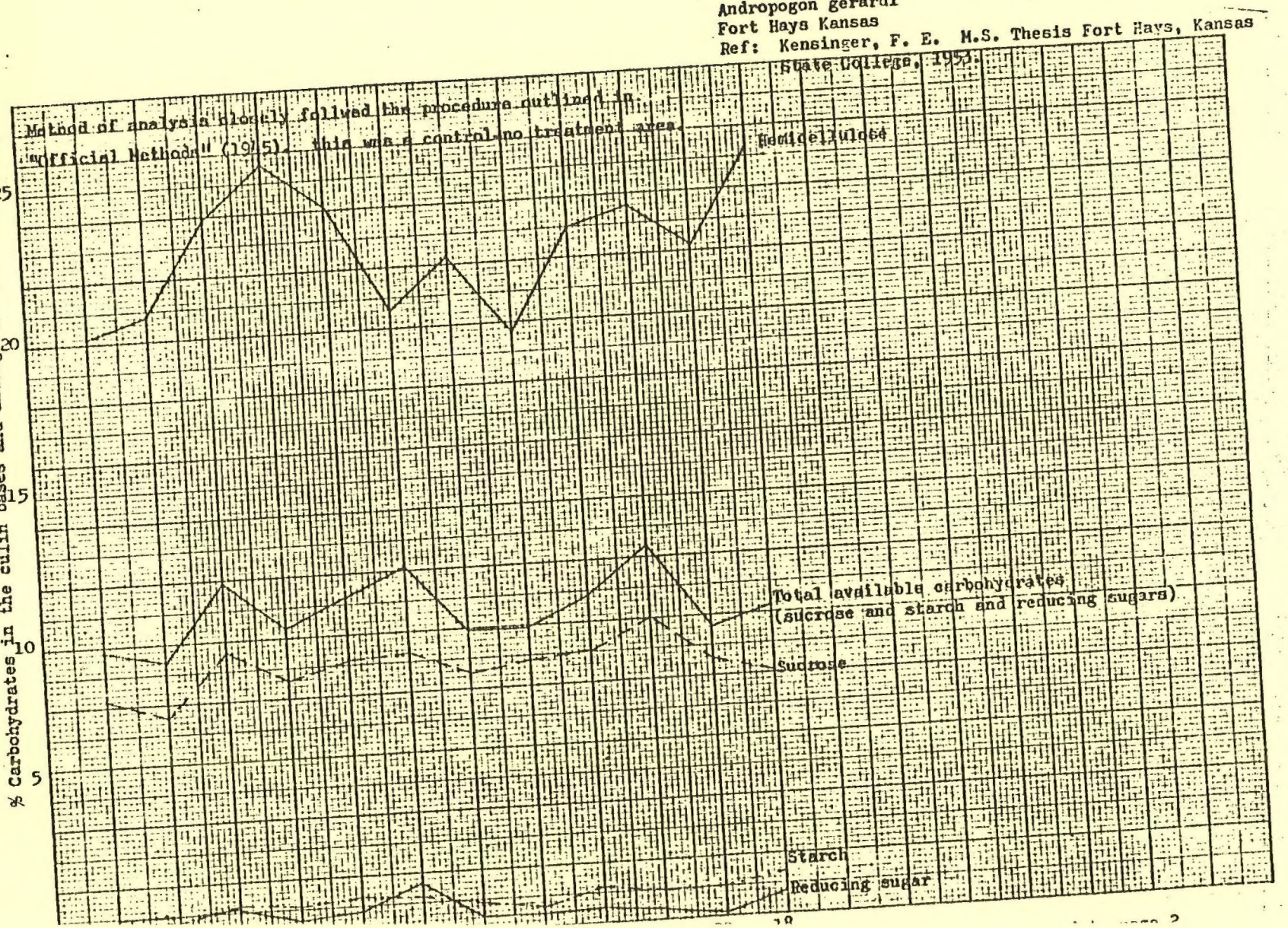

Method of analysis closely followed the procedure outlined in "Official Methods" (1945). This was a control - no clipping.
% Carbohydrates in the culin basea and underground portions to a 4 inch depth.
25
20
15
10
5
Hemicellulose
Total available carbohydrates (sucrose and starch and reducing sugars)
Sucrose
Starch
Reducing sugars

Continuation of Agropyron smithii

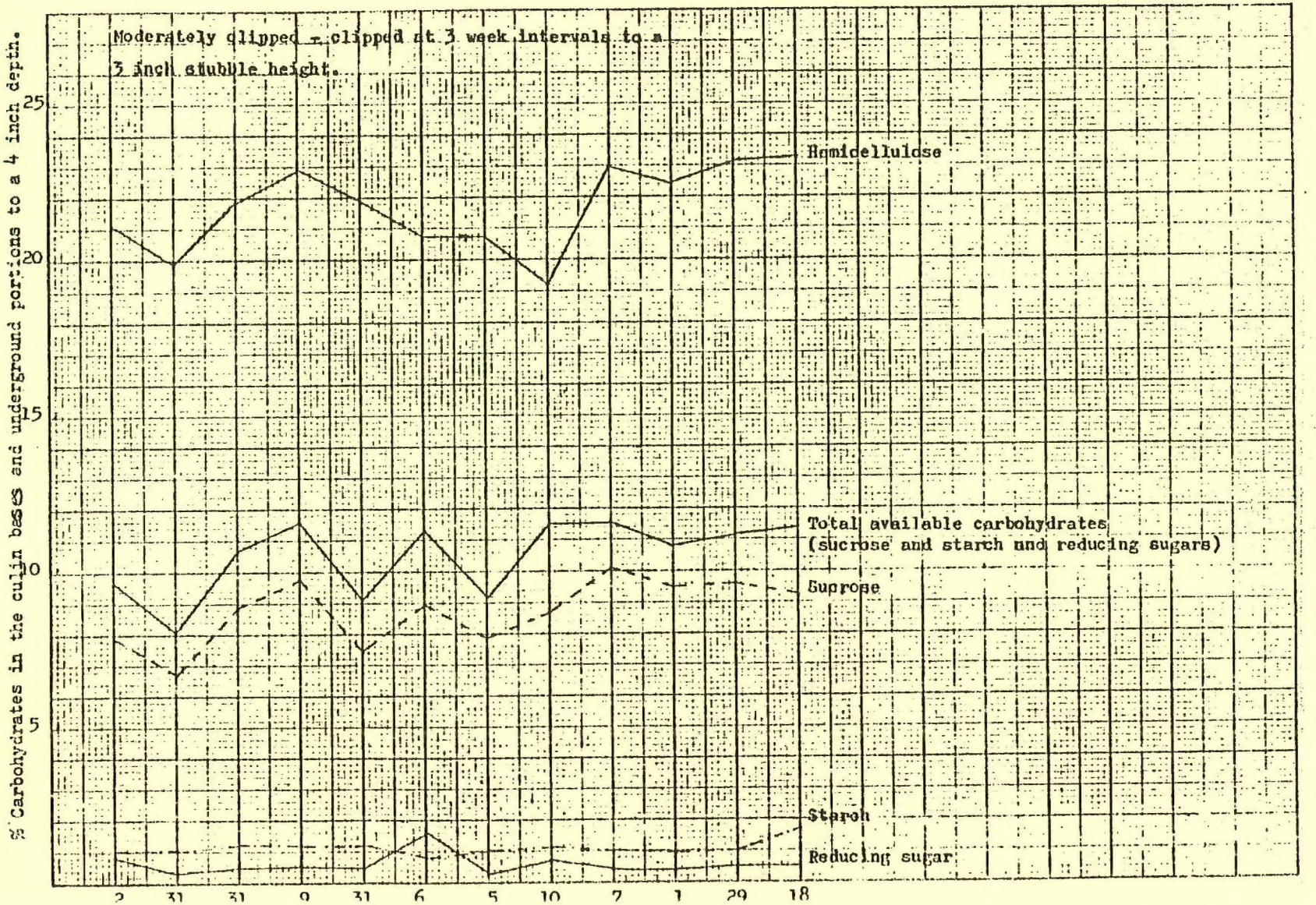


Continuation of
Agropyron smithii

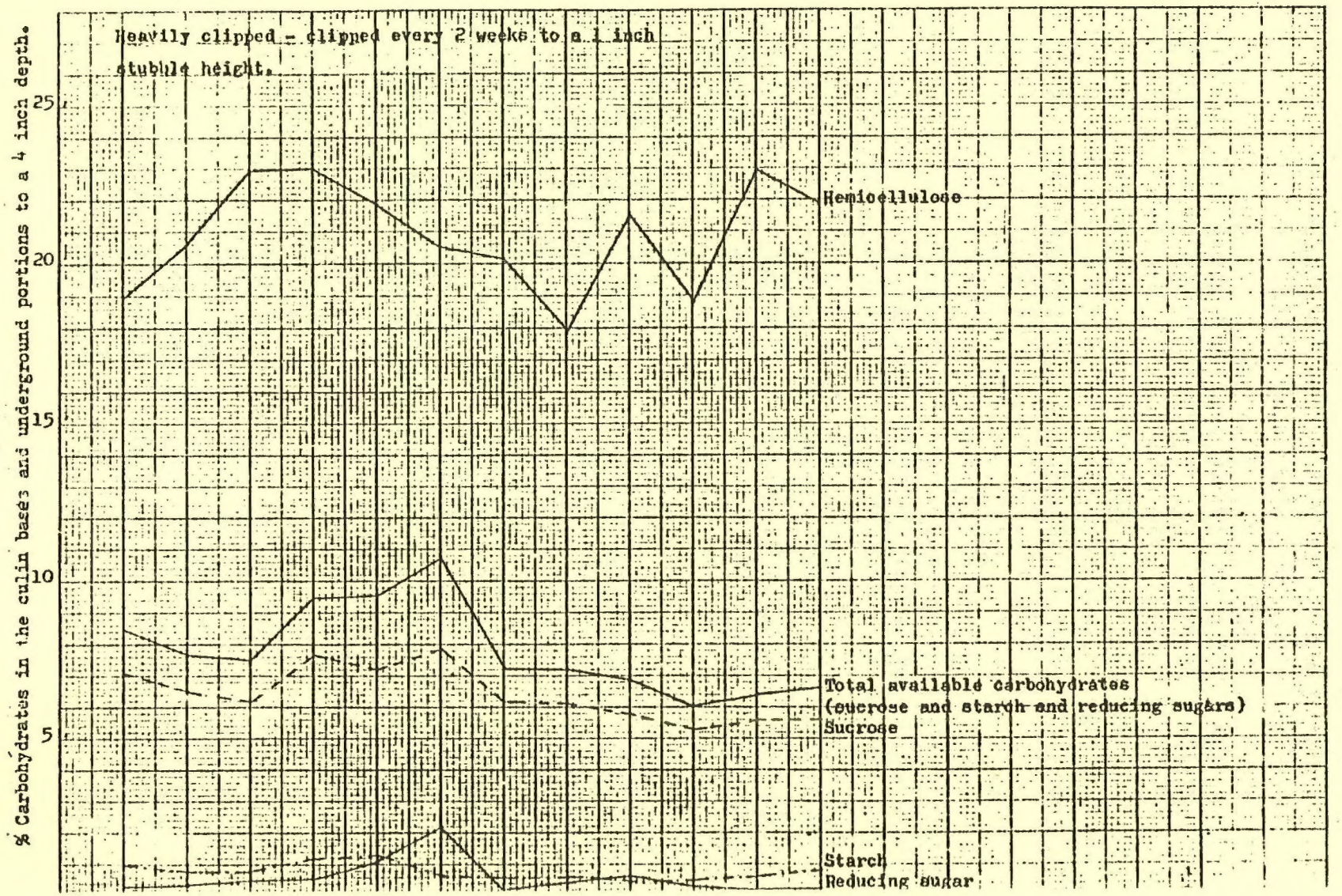


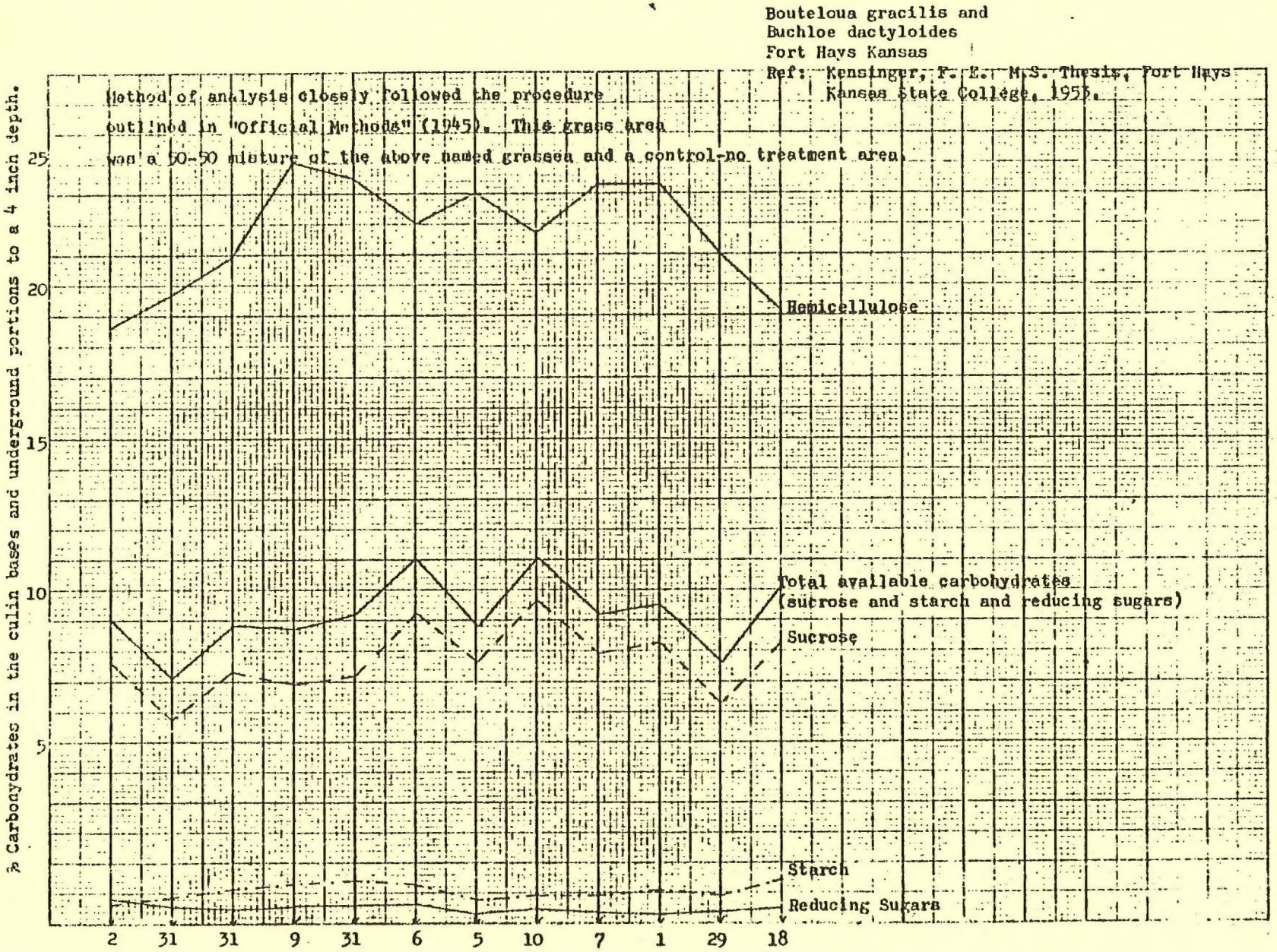

Andropogon gerardi
Fort Hays Kansas
Ref: Kensinger, F. E. M.S. Thesis Fort Hays, Kansas State College, 1953.
Method of analysis closely followed the procedure outlined in "Official Methods" (1945). This was a control-no treatment area.
% Carbohydrates in the culin bases and underground portions to a 4 in. depth.
25
20
15
10
5
Hemicellulose
Total available carbohydrates (sucrose and starch and reducing sugars)
Sucrose
Starch
Reducing sugar

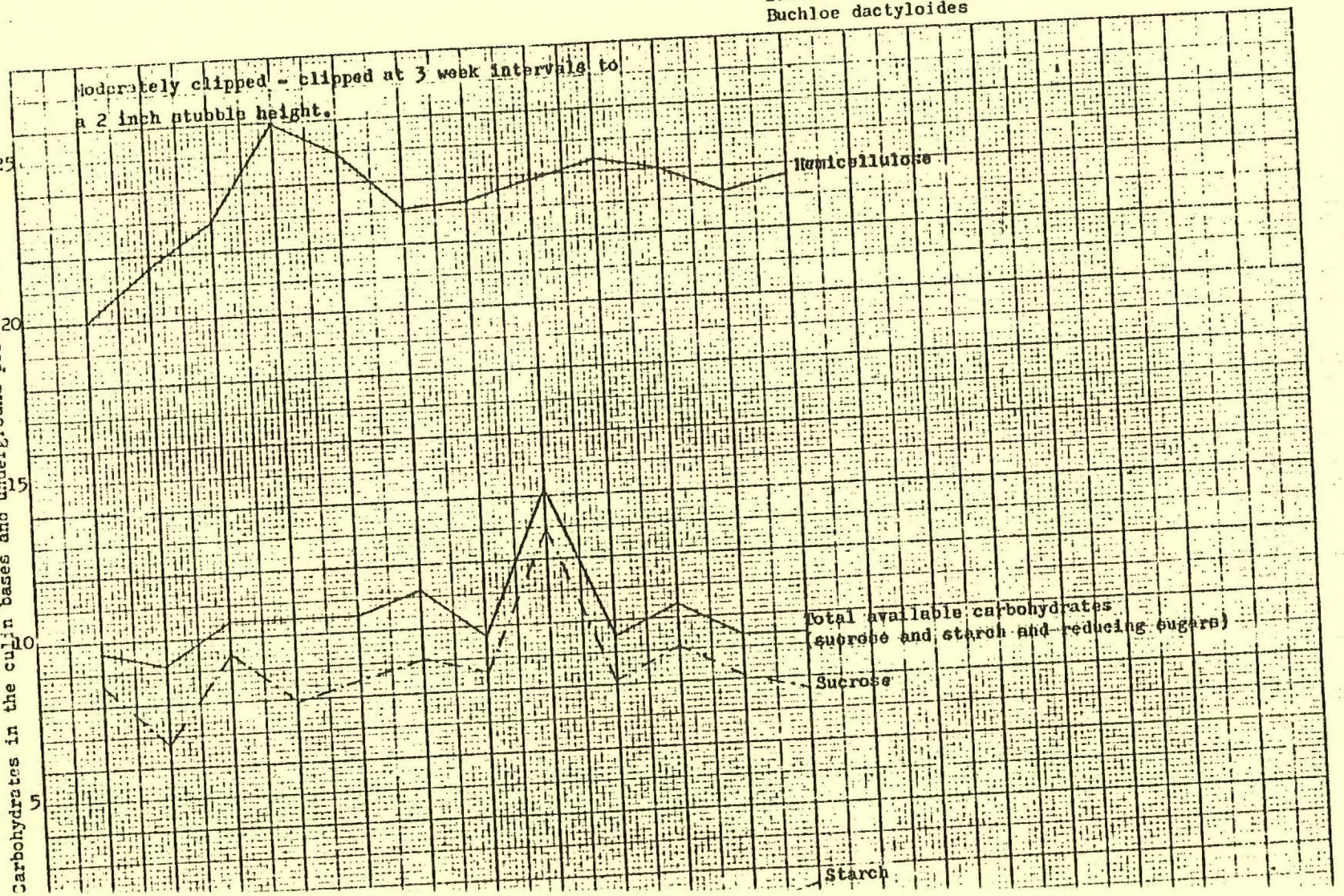
Continuation of
Andropogon gerardi

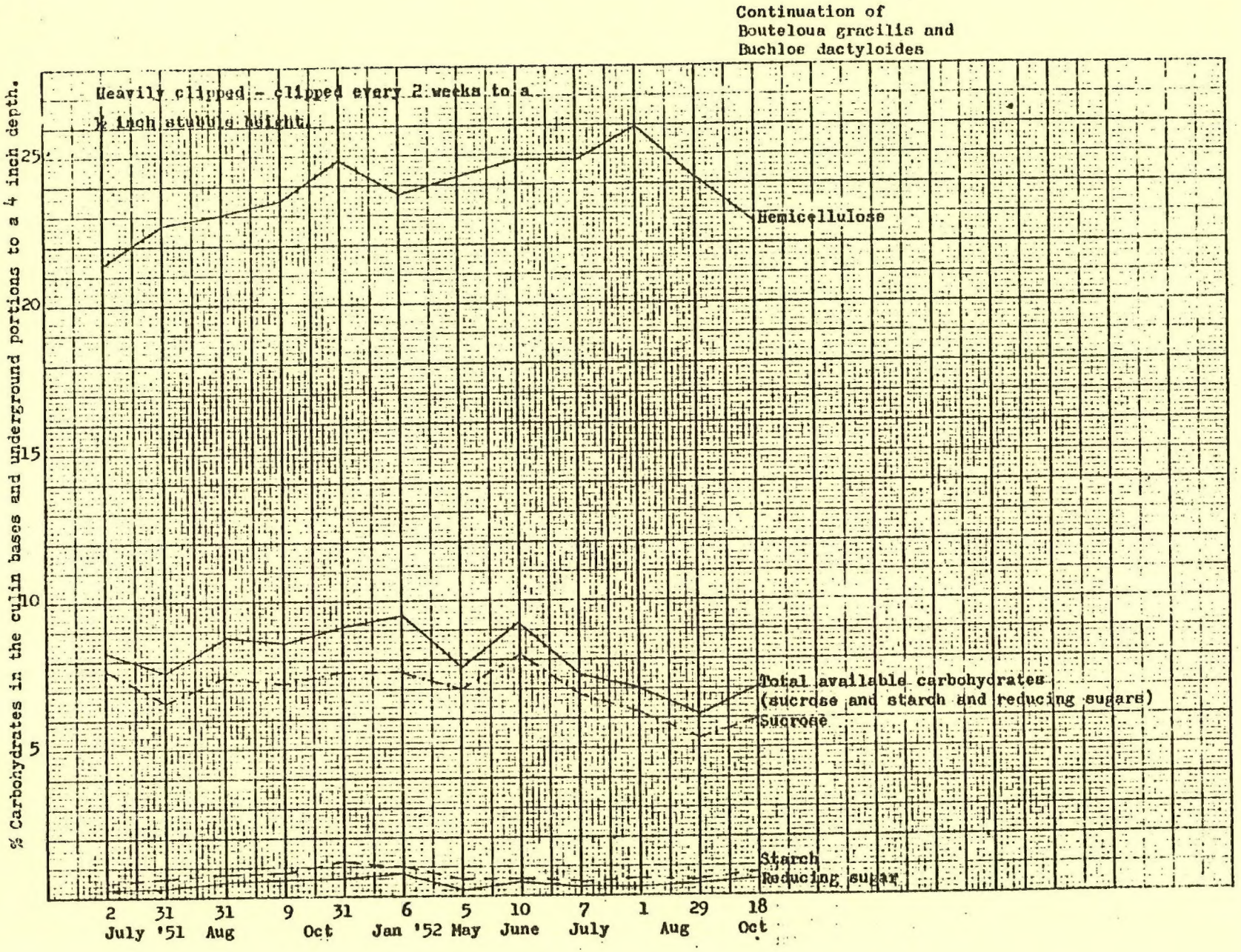


Continuation of
Andropogon gerardi



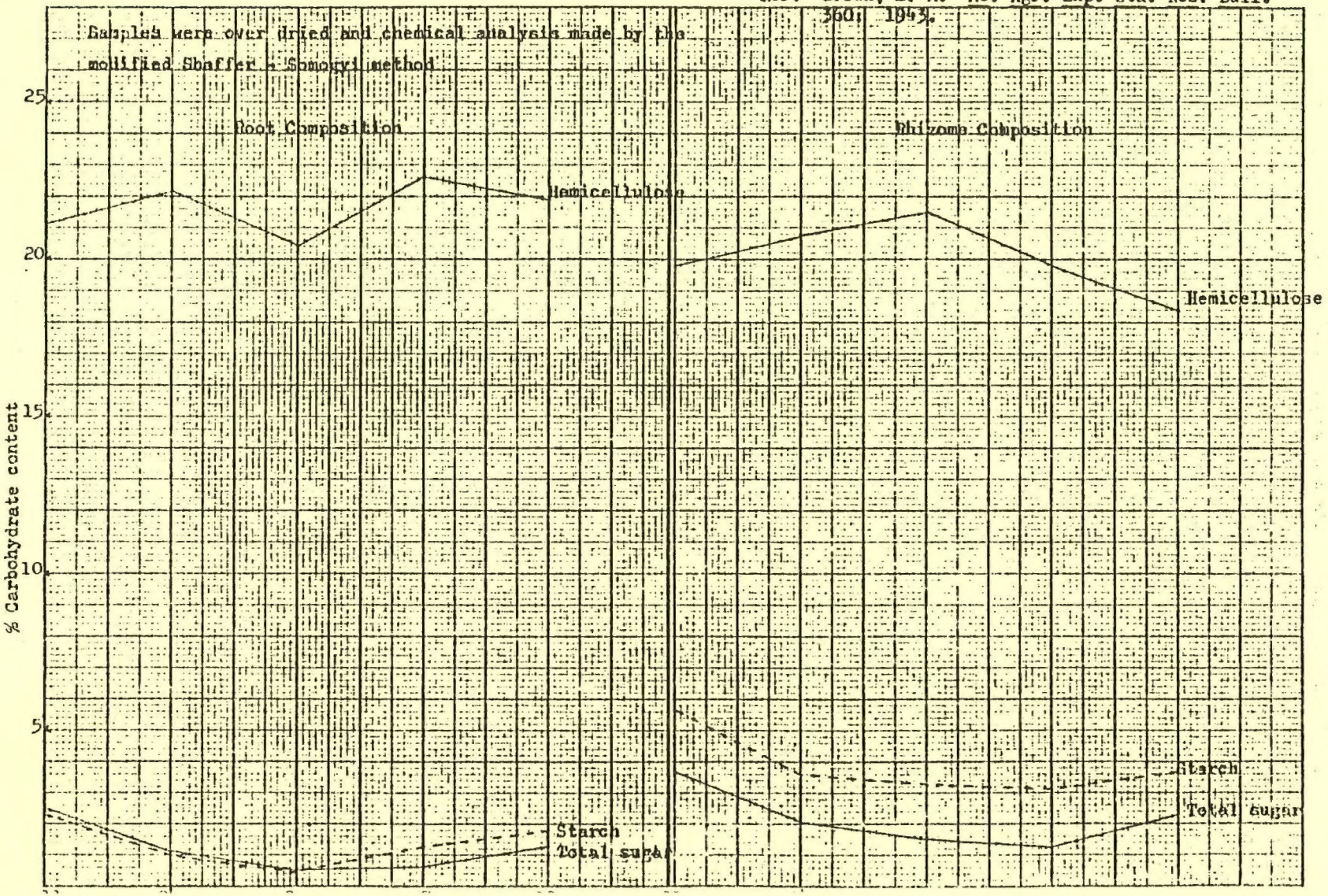

Bouteloua gracilis and
Buchloe dactyloides
Fort Hays Kansas
Ref: Kensinger, F. E. M.S. Thesis, Fort Hays
Kansas State College, 1955.
Method of analysis closely followed the procedure
outlined in "Official Methods" (1945). This grass area
was a 50-50 mixture of the above named grasses and a control-no treatment area.
% Carbohydrates in the culin bases and underground portions to a 4 inch depth.
25
20
15
10
5
Hemicellulose
Total available carbohydrates
(sucrose and starch and reducing sugars)
Sucrose
Starch
Reducing Sugars
2
31
31
9
31
6
5
10
7
1
29
18

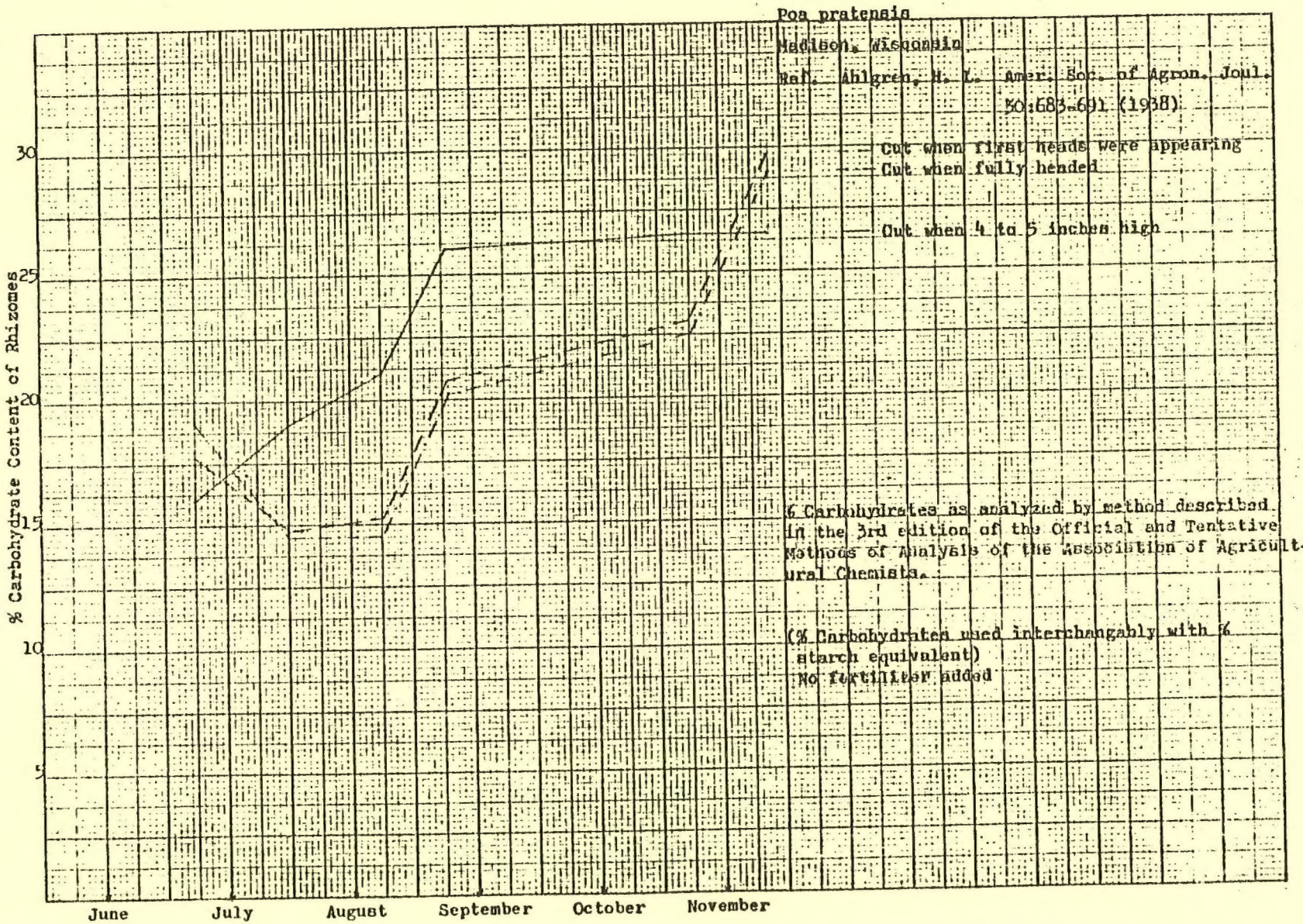

Continuation of
Bouteloua gracilis and
Buchloe dactyloides
Moderately clipped - clipped at 3 week intervals to
a 2 inch stubble height.
Carbohydrates in the culin bases and underground portions to a 4 inch depth.
25
20
15
10
5
Hemicellulose
Total available carbohydrates
(sucrose and starch and reducing sugars)
Sucrose
Starch

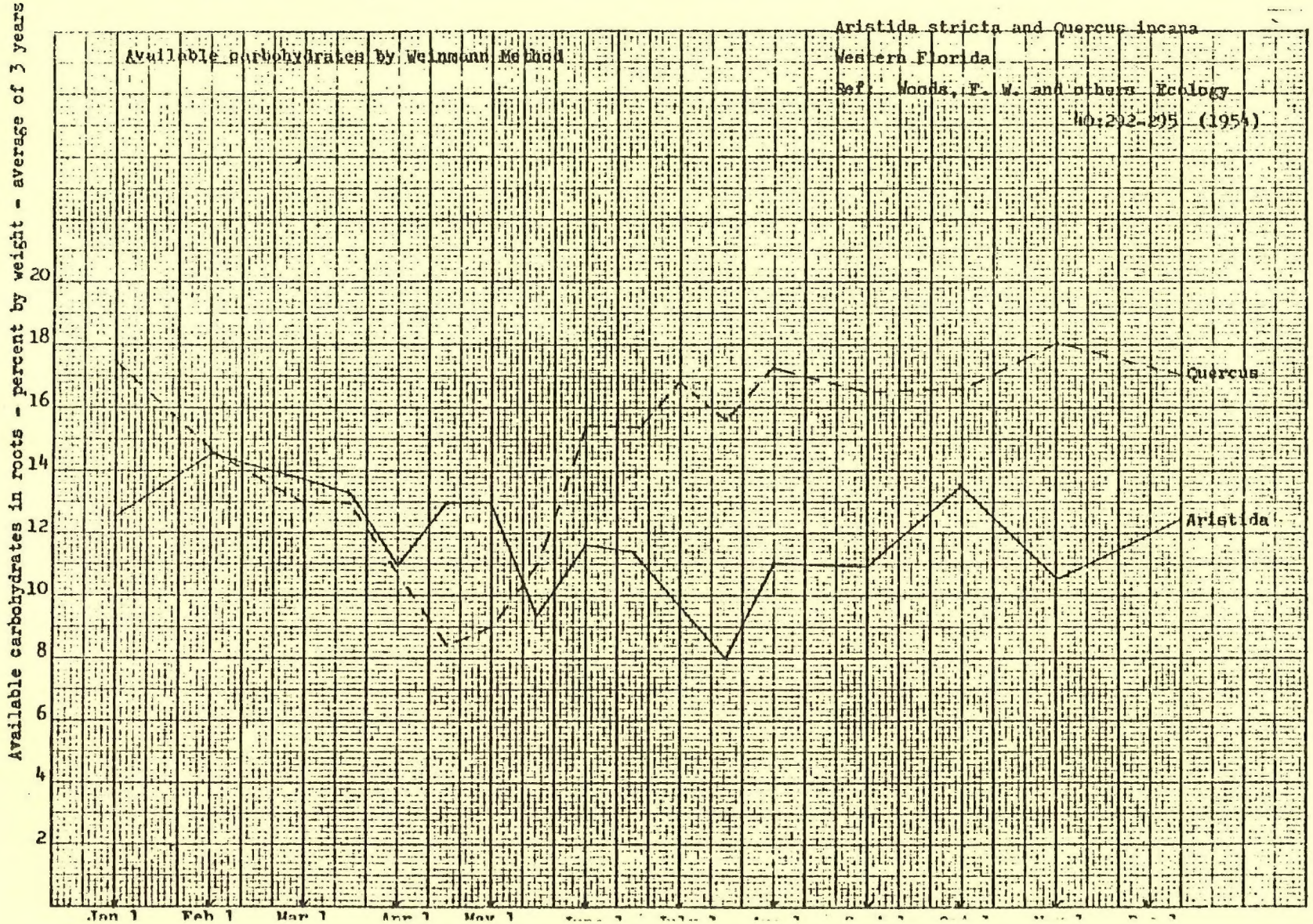

Continuation of
Bouteloua gracilis and
Buchloe dactyloides
Heavily clipped - clipped every 2 weeks to a
½ inch stubble height.
% Carbohydrates in the culm bases and underground portions to a 4 inch depth.
25
20
15
10
5
Hemicellulose
Total available carbohydrates
(sucrose and starch and reducing sugars)
Sucrose
Starch
Reducing sugar
2 July '51
31 Aug
31 Aug
9 Oct
31 Oct
6 Jan '52
5 May
10 June
7 July
1 Aug
29 Aug
18 Oct

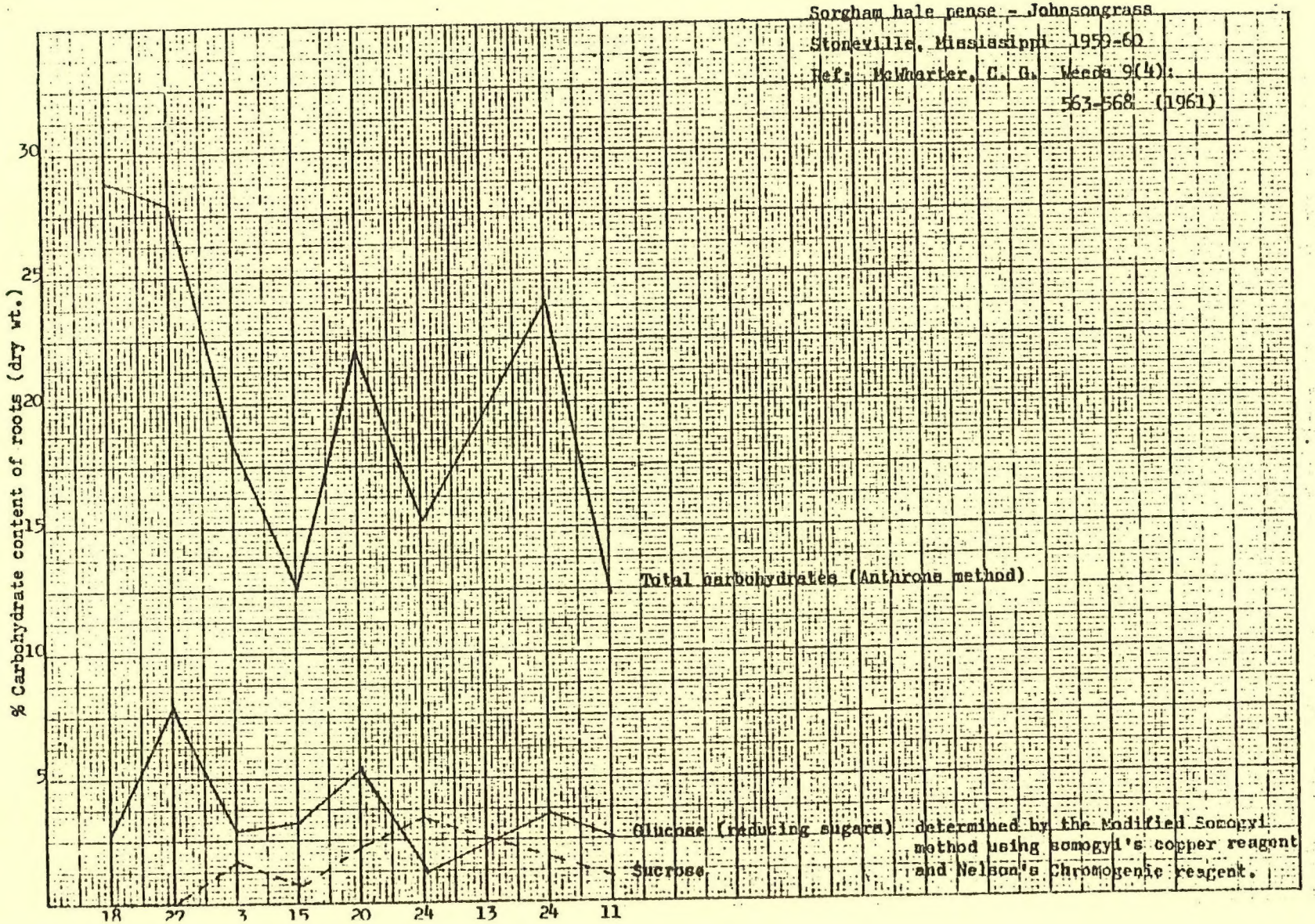
Poa pratensis
Columbia, Missouri
Ref: Brown, E. M. Mo. Agr. Exp. Sta. Res. Bull. 360; 1943.

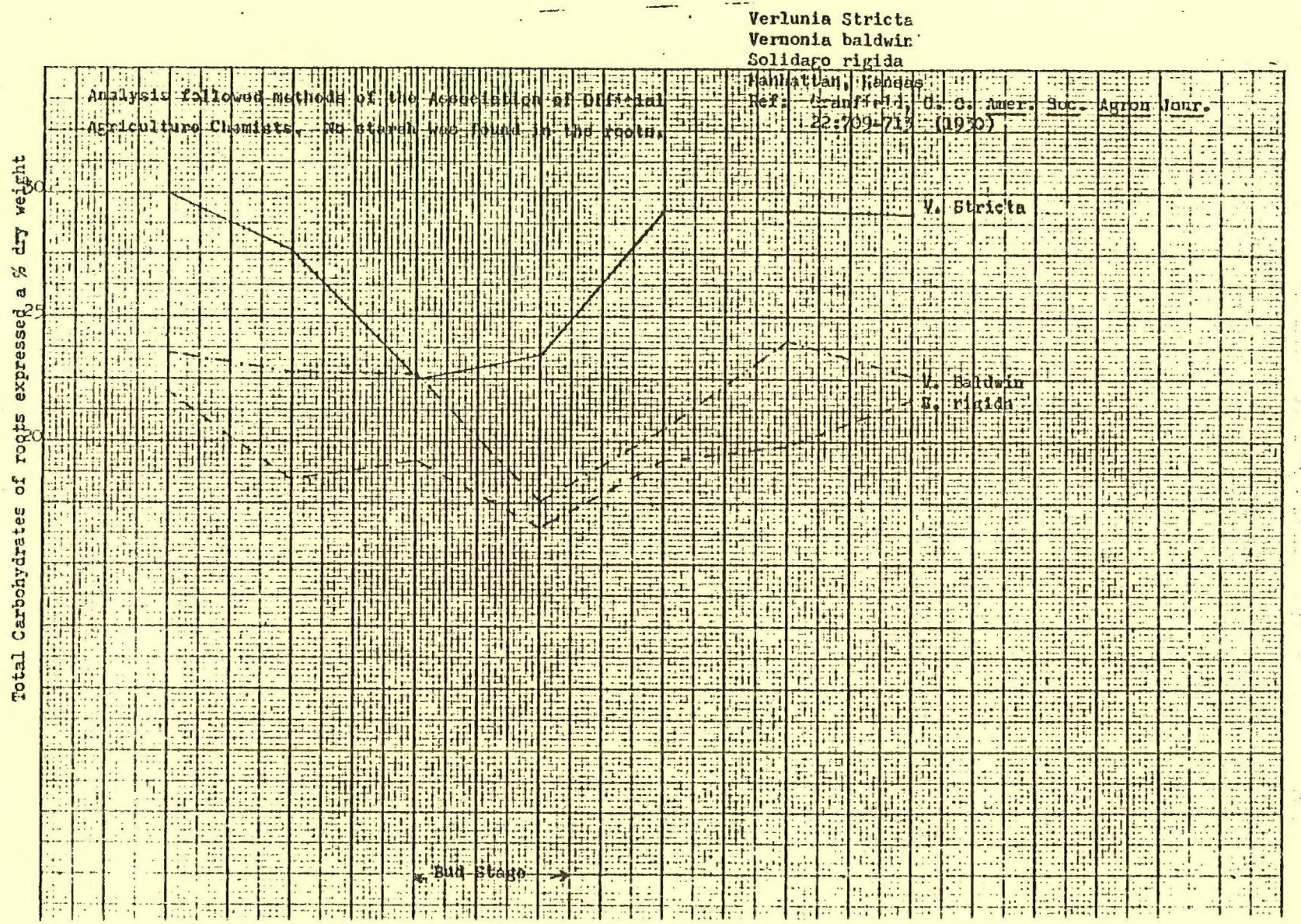
Samples were over dried and chemical analysis made by the modified Shaffer - Somogyi method




Poa pratensis
Madison, Wisconsin
Ref. Ahlgren, H. L. Amer. Soc. of Agron. Jour. 30:683-691 (1938)
Cut when first heads were appearing
Cut when fully headed
Cut when 4 to 5 inches high
% Carbohydrates as analyzed by method described in the 3rd edition of the Official and Tentative Methods of Analysis of the Association of Agricultural Chemists.
(% Carbohydrates used interchangably with % starch equivalent)
No fertilizer added
% Carbohydrate Content of Rhizomes
30
25
20
15
10
5
June
July
August
September
October
November

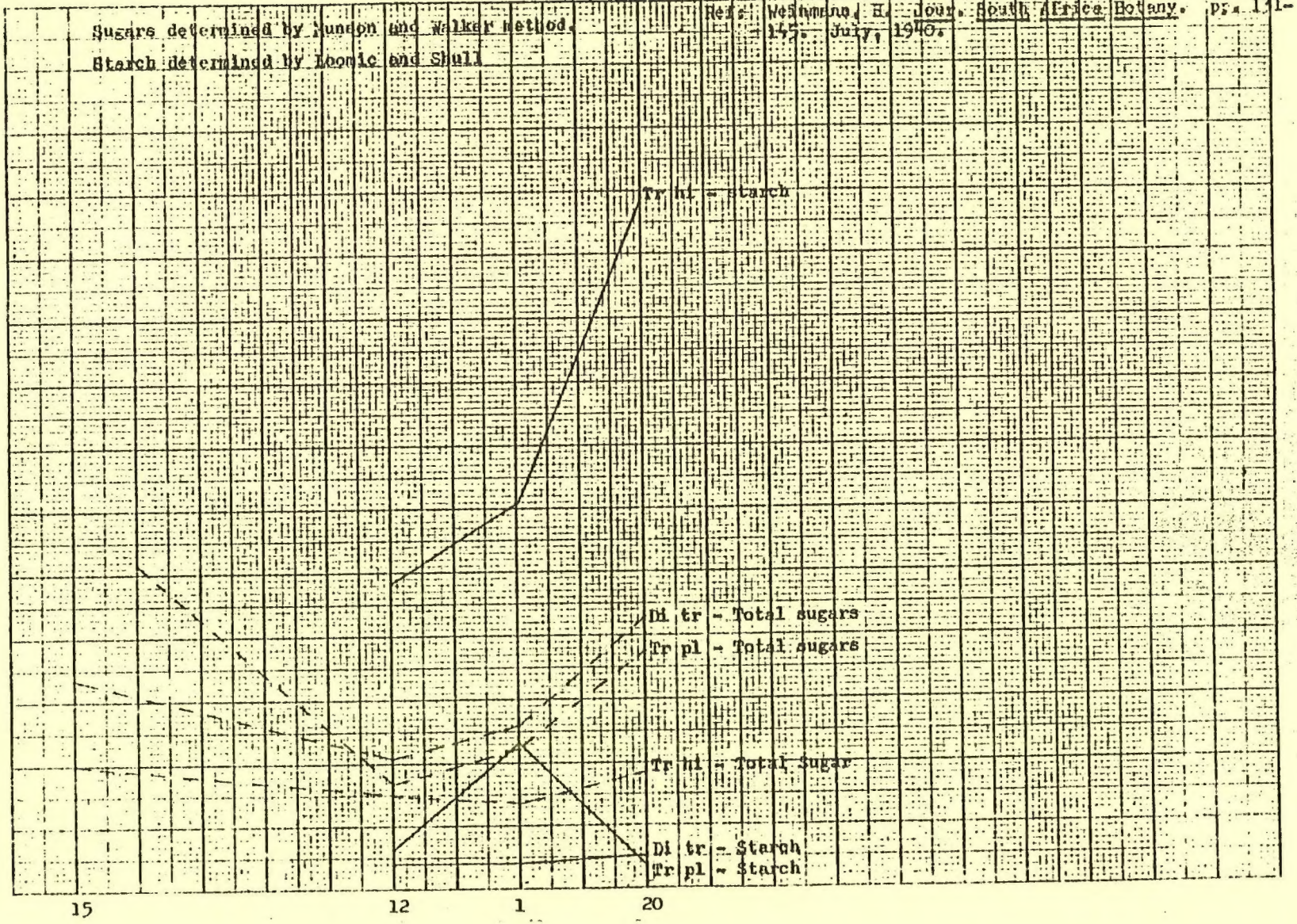

Aristida stricta and Quercus incana
Western Florida
Ref. Woods, F. W. and others Ecology
40:292-295 (1954)
Available carbohydrates by Weinmann Method
Available carbohydrates in roots - percent by weight - average of 3 years
20
18
16
14
12
10
8
6
4
2
Quercus
Aristida
Jan 1
Feb 1
Mar 1
Apr 1
May 1


Sorghum hale pense - Johnsongrass
Stoneville, Mississippi 1959-60
Ref: McWhorter, C. G. Weeds 9(4):
563-568 (1961)
% Carbohydrate content of roots (dry wt.)
30
25
20
15
10
5
Total carbohydrates (Anthrone method)
Glucose (reducing sugars) determined by the modified Somogyi
method using Somogyi's copper reagent
and Nelson's Chromogenic reagent.
Sucrose
18
22
3
15
20
24
13
24
11

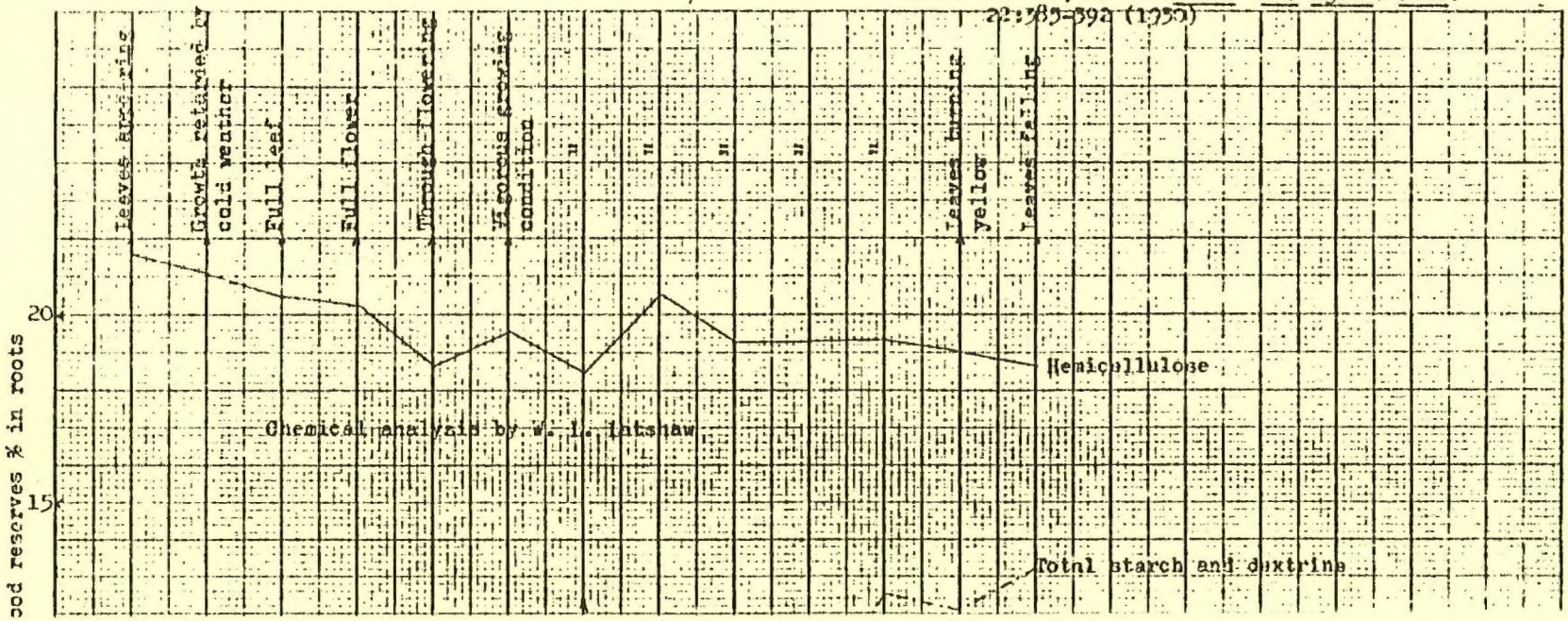

Verlunia Stricta
Vernonia baldwin
Solidago rigida
Manhattan, Kansas
Ref: Cranfield, U. C. Amer. Soc. Agron Jour. 22:709-713 (1930)
Analysis followed methods of the Association of Official Agriculture Chemists. No starch was found in the roots.
Total Carbohydrates of roots expressed a % dry weight
30
25
20
V. Stricta
V. Baldwin
S. rigida
Bud Stage

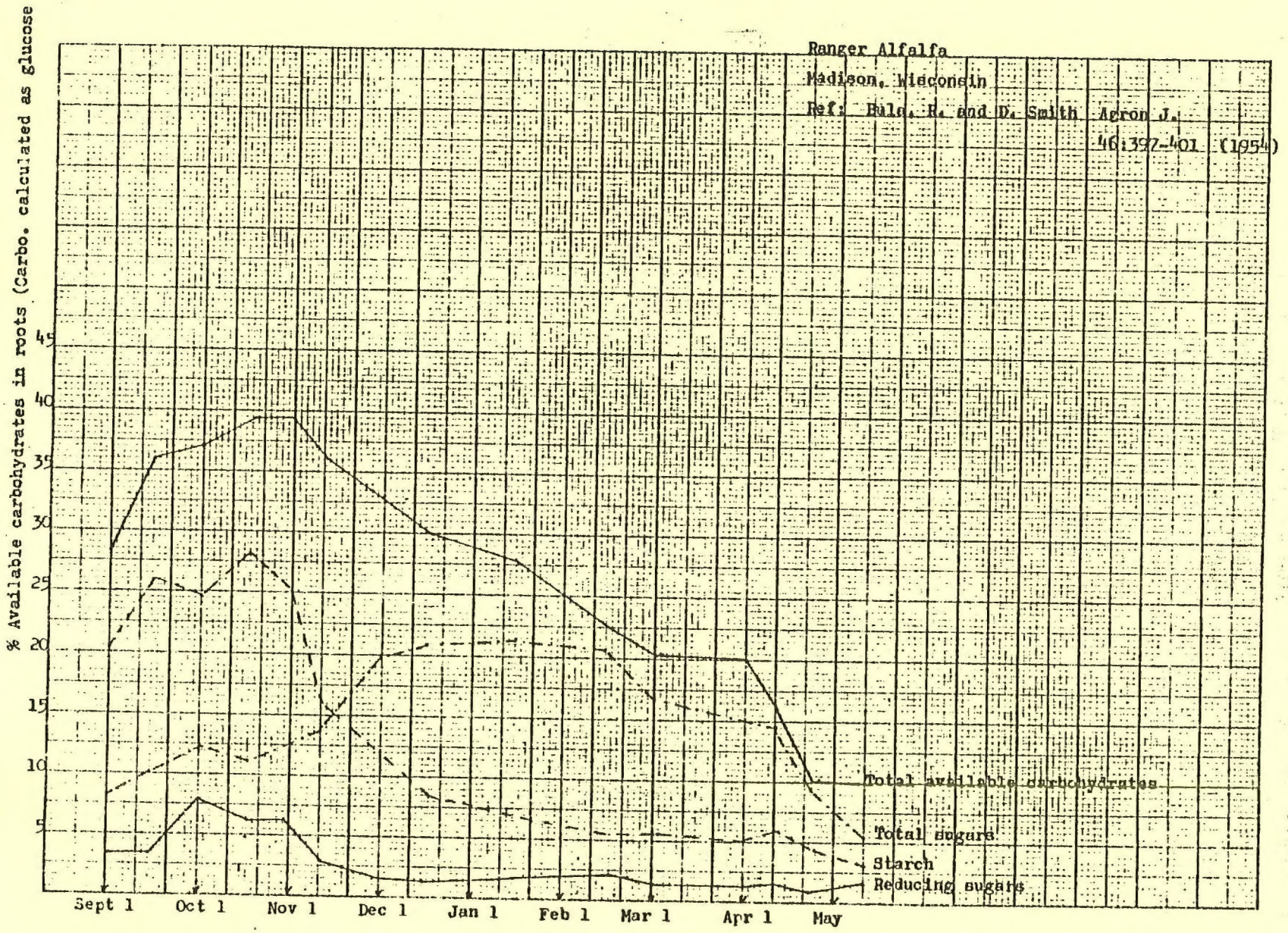
Trachypogon plumosus
Tristachya hispida
Digitaria tricholainoides
Johannesburg, South Africa

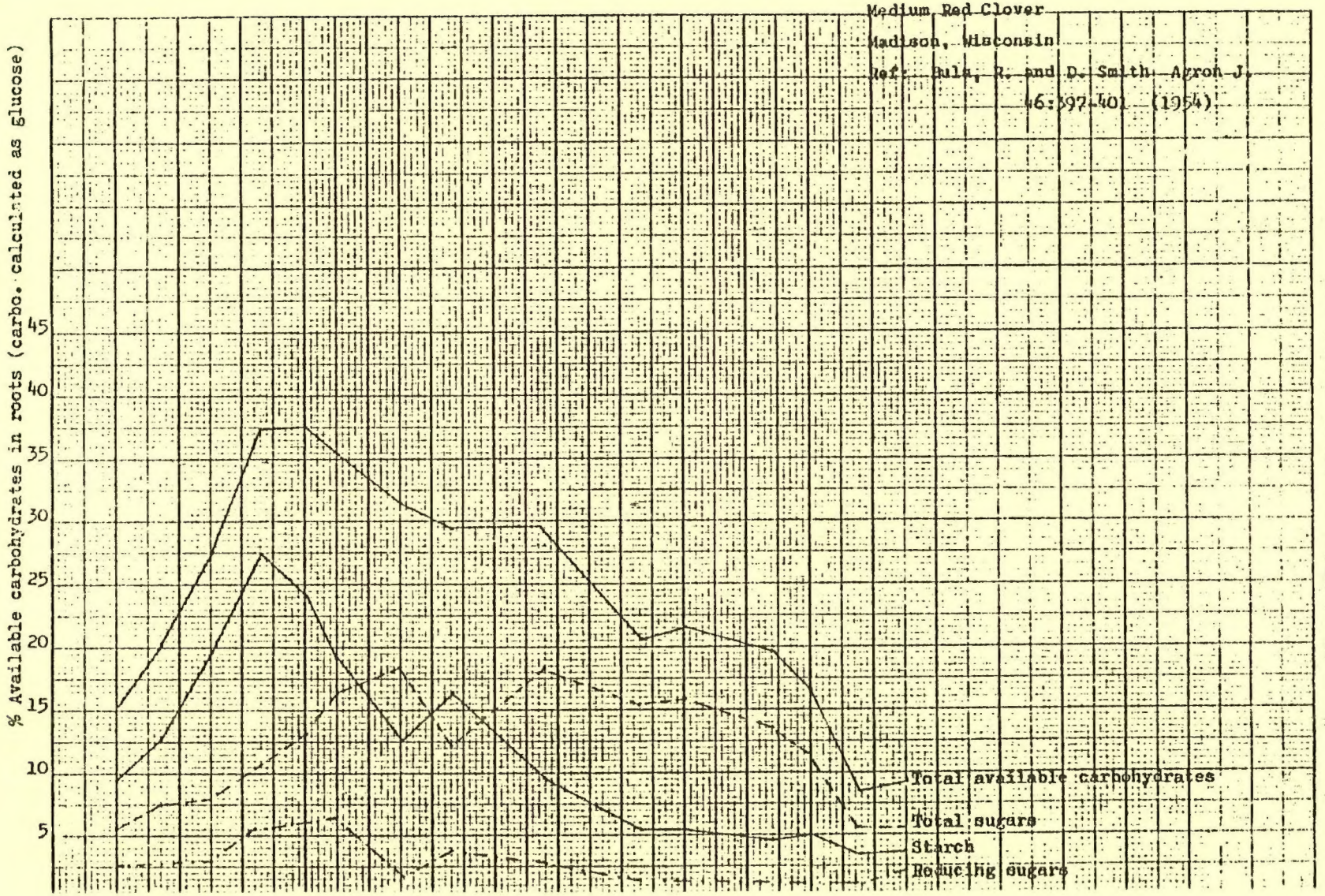
Refs: Weimann, H. Jour. South Africa Botany. pp. 131-175. July, 1940.

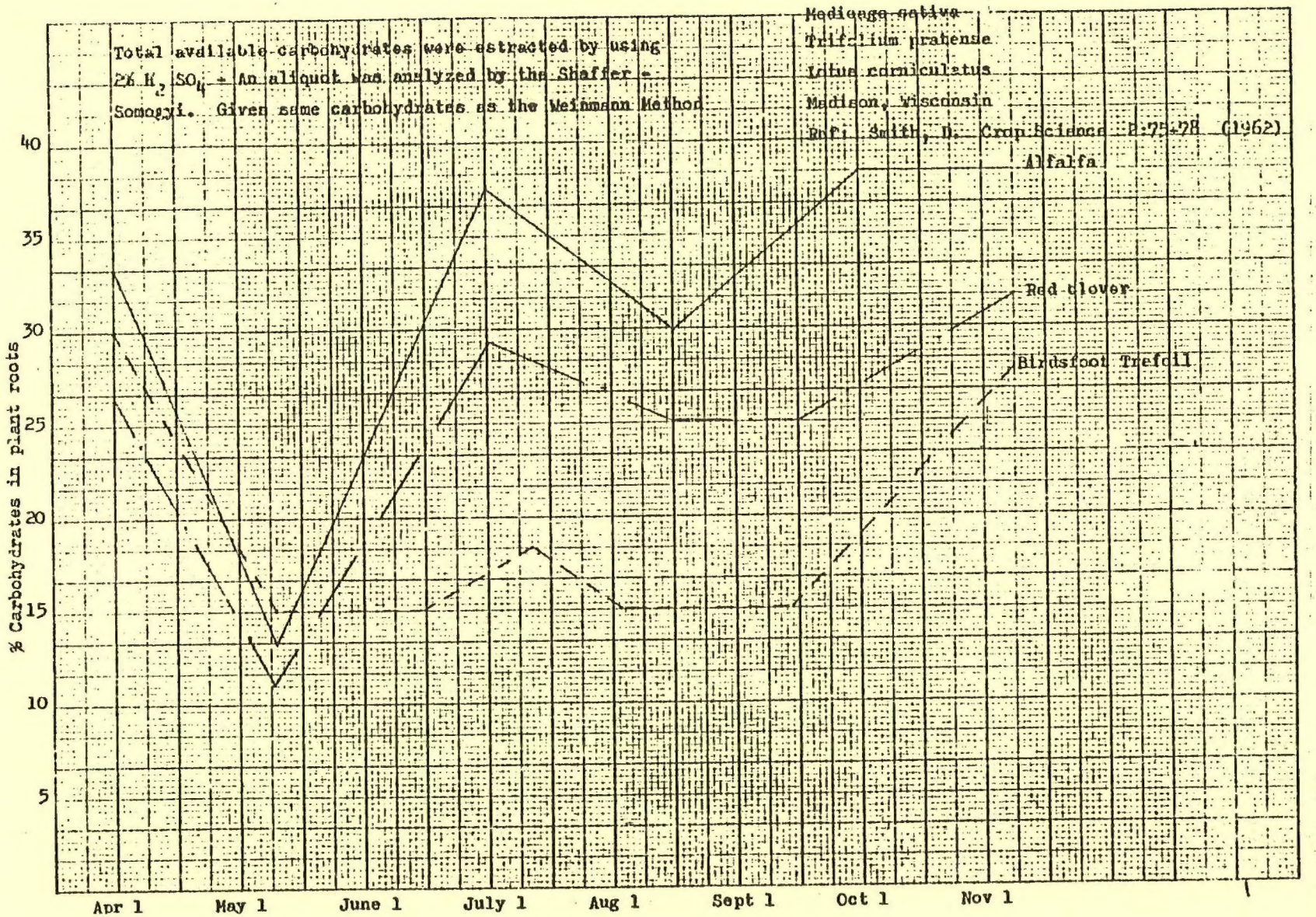


Symphoricarpos vulgairs
Manhattan, Kansas
Ref: Aldous, A. E. Amer. Soc. Agron. Jour.
22:785-792 (1930)

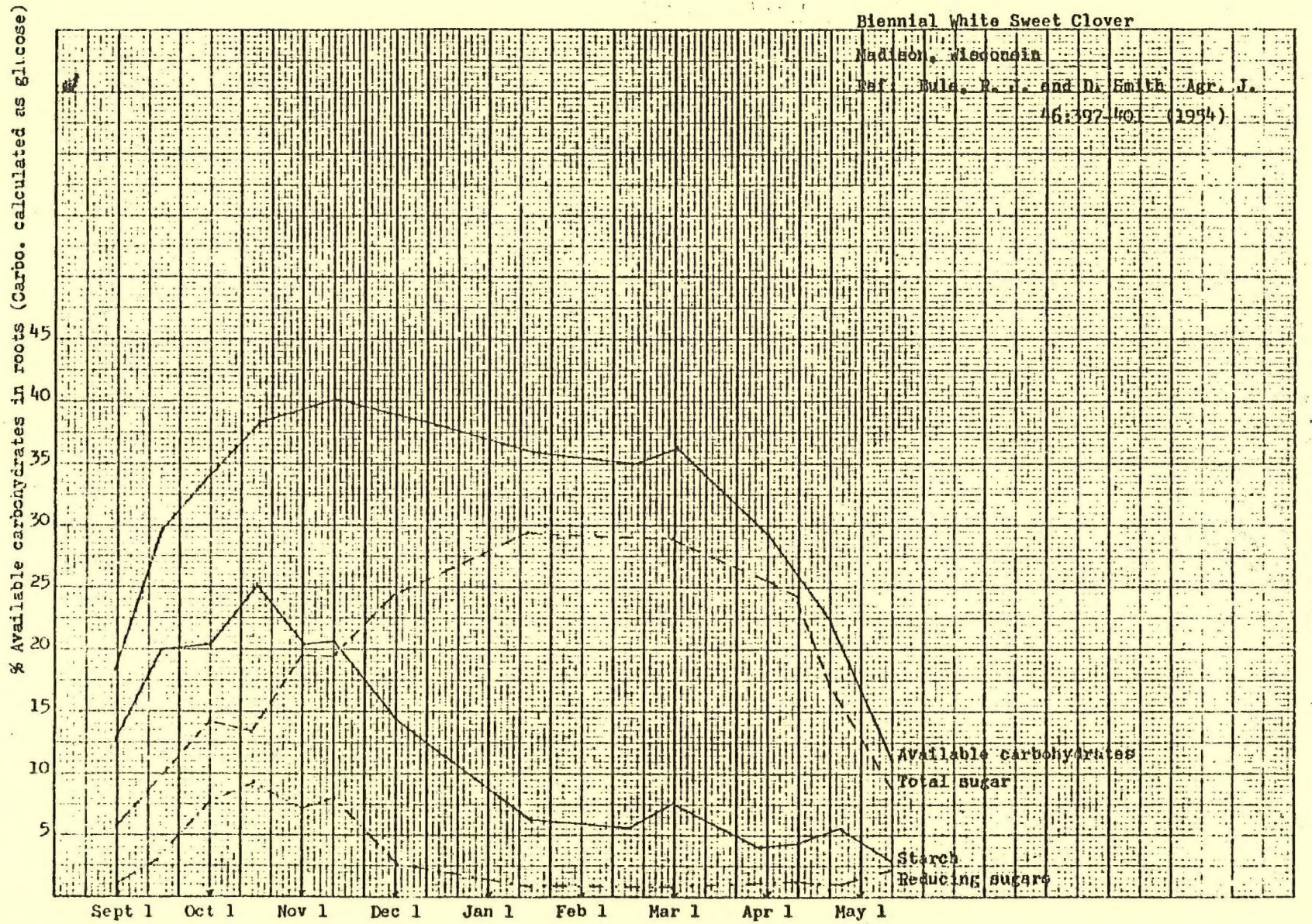


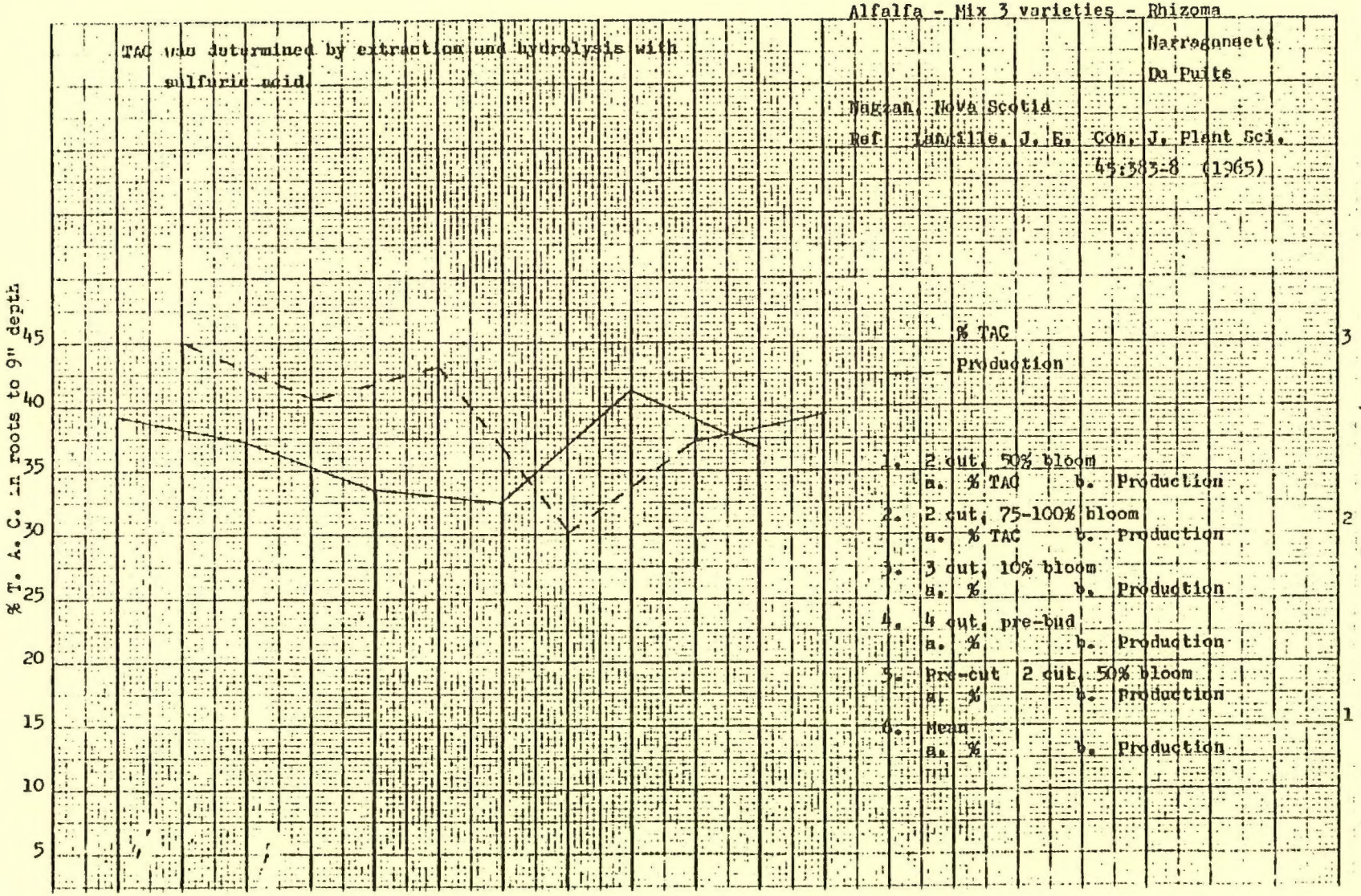

Ranger Alfalfa
Madison, Wisconsin
Ref: Hulé, R. and D. Smith Agron J.
46:397-401 (1954)
% Available carbohydrates in roots (Carbo. calculated as glucose
45
40
35
30
25
20
15
10
5
Sept 1
Oct 1
Nov 1
Dec 1
Jan 1
Feb 1
Mar 1
Apr 1
May
Total available carbohydrates
Total sugars
Starch
Reducing sugars


Medium Red Clover
Madison, Wisconsin
Ref: Bula, R. and D. Smith Agron J.
46:397-401 (1954)
% Available carbohydrates in roots (carbo. calculated as glucose)
45
40
35
30
25
20
15
10
5
Total available carbohydrates
Total sugars
Starch
Reducing sugars


Medicago sativa
Trifolium pratense
Lotus corniculatus
Madison, Wisconsin
Ref: Smith, D. Crop Science 2:7-28 (1962)
Total available carbohydrates were extracted by using 2% H_2SO_4 + An aliquot was analyzed by the Shaffer - Somogyi. Given same carbohydrates as the Weinmann Method
Alfalfa
Red clover
Birdsfoot Trefoil
% Carbohydrates in plant roots
40
35
30
25
20
15
10
5
Apr 1
May 1
June 1
July 1
Aug 1
Sept 1
Oct 1
Nov 1

Cynodon plectostachyus
Carbohydrates
10
11
12
13
14


Biennial White Sweet Clover
Madison, Wisconsin
Ref: Hyle, R. J. and D. Smith Agr. J. 46:397-401 (1954)
% Available carbohydrates in roots (Carbo. calculated as glucose)
45
40
35
30
25
20
15
10
5
Sept 1
Oct 1
Nov 1
Dec 1
Jan 1
Feb 1
Mar 1
Apr 1
May 1
Available carbohydrates
Total sugar
Starch
Reducing sugars


Alfalfa - Mix 3 varieties - Rhizoma
Narragansett
Du Puits
Nagzan, Nova Scotia
Ref Tanville, J. E. Can. J. Plant Sci. 45:383-8 (1965)
TAC was determined by extraction and hydrolysis with sulfuric acid.
% TAC
Production
1. 2 cut, 50% bloom
a. % TAC b. Production
2. 2 cut, 75-100% bloom
a. % TAC b. Production
3. 3 cut, 10% bloom
a. % b. Production
4. 4 cut, pre-bud
a. % b. Production
5. Pre-cut 2 cut, 50% bloom
a. % b. Production
6. Mean
a. % b. Production
% T. A. C. in roots to 9" depth
5
10
15
20
25
30
35
40
45
Forage - Tons/acre
1
2
3